

Project # 1

Anderson, Ava

Assessing the Efficacy of Botanical Repellents Against Blacklegged Ticks

Completed Project, Health & Medical

Lyme disease is the most commonly transmitted vector disease. The usage of repellents is an important method to reduce cases. Many consumers have concerns about deet, so they use botanical repellents. These repellents are impractical because they require frequent reapplication. This research explores what repellents are practical by comparing botanical repellents to deet and observing their efficacy at two time points. The repellents were tested using a filter paper bioassay. A 7.5 cm by 12 3/4 cm box was marked on sheets 5" x 6" P8 filter paper. Within this box, a 9.5cm x 4cm box was marked. 300 microliters of the repellent were painted onto the outer box and allowed to dry for one hour. Six ticks were placed on the untreated area of the filter paper using forceps. The ticks' behavior was observed and recorded for 3 minutes. They were then removed from the paper. The filter paper dried for another hour, and testing was repeated with new ticks. Ethanol, deet, and Nantucket Spider Repellent were used in all trials. 3% nootkatone was used in the first and second trials. 5% nootkatone was used in the second and third trials. Based on the preliminary analysis, the botanical repellents were ineffective. Final statistical analysis has not been completed. A Fisher's Exact test will be used to determine if the data was statistically significant. Many consumers prefer botanical repellents over deet, so the preliminary results show a need for more consumer education to promote effective repellents.

Ridgefield High School

Teacher: Aine Kapell

Project # 2

Armetta, Giovanna

Drosophila melanogaster locomotion, myonuclei size, and myonuclei position associated with differential gene expression

Completed Project, Health & Medical

Muscular Dystrophies (MDs), characterized by progressive muscle wasting, are associated with 1 in 2,500 deaths in the United States each year. Many MDs can also be characterized by mispositioned nuclei within the muscle fibers. However, it is unclear whether diseased muscles malfunction due to the inability to exert sufficient force or because they experience increased muscle fatigue as a result of how mutations affect exertion levels. Using the GAL4-UAS expression system, eight genes critical to correct muscle function and/or mitochondrial function were either overexpressed or knocked down to simulate muscle disease in the model organism, *Drosophila melanogaster*. Mutant behaviors during locomotive assays were subsequently analyzed to determine whether the defective muscles were incapable of contracting or if the muscles were merely fatigued. All mutant larvae stopped more frequently and moved slower than controls, and in some cases, the larvae were too weak to move at all. However, when the larvae did move, the step sizes between mutants and controls were comparable, suggesting that mutant muscles properly contract. Paired with the observation that mutant larvae stop more frequently, these data indicate that mutant muscles fatigue more easily than controls. These findings highlight an important distinction that has long eluded researchers and shed light on the mechanisms that lead to muscle disease. Now, future research can focus on identifying therapies, both genetic and physical, that specifically address improving muscle endurance instead of merely increasing a patient's range of motion to provide better quality and prolonged life for affected individuals.

King School

Teacher: Victoria Schulman

Project # 3

Axel, Brooke

Cluster B Personality Disorders and their Relationship with Specific Neuropeptides

Completed Project, Behavioral

Cluster B personality disorders (antisocial, borderline, histrionic, and narcissistic personality disorder) are enduring mental disorders characterized by dramatic, overly-emotional, or erratic thinking or behavior. Individuals with these disorders are plagued by symptoms that, among other things, interfere with their ability to form healthy interpersonal relationships. Growing evidence suggests that the neuropeptide oxytocin, as well as the related neuropeptide vasopressin, may be essential to understanding and treating these disorders. A systematic review of literature was conducted using public data from published studies on the effects of oxytocin, vasopressin, and/or their antagonists on people with one or more cluster B personality disorder or healthy participants with symptoms commonly seen in these disorders. These studies were found through searches of various databases for peer-reviewed journal articles containing relevant search terms in their abstracts. Through this review, oxytocin receptor genotype was found to have an effect on the development of several antisocial traits as well as borderline symptoms. Oxytocin administration had diverse effects on behaviors associated with antisocial personality disorder, with some studies finding desirable, socially positive effects, and some finding exactly the opposite. The same was true for studies on borderline personality disorder. While several studies regarding the effects of vasopressin were found, there were not enough to draw definitive conclusions. This review also highlights the lack of research exploring the relationship between oxytocin and vasopressin and narcissistic or histrionic personality disorder, which given the findings on the other cluster B personality disorders could be very beneficial.

Ridgefield High School

Teacher: Ryan Gleason

Project # 4

Babajanyan, Edgar

Inventing an Artificially Intelligent Autonomous Drone to Secure School campuses and Businesses Utilizing Computer Vision Technology to Detect Suspicious and Irregular Behaviour

Completed Project, Physical Science

Unmanned Aerial Vehicle technology is growing in usage by companies and governments. Inventing an inexpensive autonomous drone capable of capturing recordings and providing security for its users using security hardware would make public and work environments safer. The drone will be developed to scan for human behavior using custom haar cascades or the tracking of objects through video. The drone will fly autonomously by tracking its user and mapping its user's position. The student designed and created the drone utilizing a flight controller and DIY drone equipment assisted by additional components such as a camera and sensors. The autonomous system will be programmed utilizing Python and will run on a Raspberry Pi which will produce signals that a flight controller would look for to fly autonomously. The first test will have ten trials to determine the drone's accuracy in determining a disturbed body posture or suspicious activity. The second test will have five trials which will be measuring for a six by six foot distance from the user. Lastly, the drone will be tested three times for its autonomous flight time on a full charge. Current drone operations in security are highly supervised and aren't effective. People in cities, college campuses, and businesses will now have drones that require little to no supervision while securing facilities and alerting the public about disruptions or accidents with its user base.

Amity High School

Teacher: Catherine Piscitelli

Project # 5

Babajanyan, Aaron

Creating a more Effective Surgical Screw Based on the Finite Element Analysis of Three Designed Screws in a Proximal Screw Clustering in Distal Femur Fractures

Completed Project, Health & Medical

Currently, the treatment of distal femur fractures needs to be improved as the rate of successful healing is quite low because of the poor placement of surgical hardware or more commonly the malfunction of screws and/or plates. The solution is to develop a modified surgical screw based on the performance of the proximal clustering of three differently designed screws in the distal part of the femur. Three different screw types were constructed using PreForm and SOLIDWORKS, then they were imported into ScanIP and set into a virtually constructed distal femur fracture. The screw density was non-locking, the working length remained constant, the bodyweight remained constant, and the screw clustering was proximal, which is a screw configuration of one screw on the top and three on the bottom of the distal femur. A simulation was run once for each screw to determine areas of high stress, concentrations of pressure, and displacements of the screw. Afterward, the data from the first simulations were used to create a modified screw for the scenario outlined earlier. Data trends thus far show that screws with less jagged pieces allow for more areas of high stress. A second simulation with the same parameters was run and the data was compared to the first sets of data. This project has the potential to significantly increase the success rate of these surgical screws and plates in healing distal femur fractures while also avoiding more money and time spent on extra surgery for many who receive these surgeries.

Amity High School

Teacher: Catherine Piscitelli

Project # 6

Bahel, Anchal

Determining the Availability of Effective Online Triage Resources for Patients at Musculoskeletal Urgent Care Centers

Completed Project, Behavioral

Patients experience orthopedic injuries frequently and have previously relied on emergency departments (EDs) to receive care. Musculoskeletal Urgent Care Centers (MUCCs) have proved to be an alternative to provide more efficient and timely care. The purpose of this project was to determine the availability of effective online triage resources to ensure patients are directed to appropriate treatment facilities while also characterizing potential factors that would have an increased likelihood of triage resource availability. It was hypothesized that there aren't a sufficient amount of online triage resources on how to manage musculoskeletal injuries due to a proven increase in wait times, overcrowding, and insufficient patient care in EDs. The IV was the MUCCs along with their affiliation and location. The DV is the breakdown of both the specific and the number of triage resources that are available online. All MUCCs in the United States were compiled by using google maps search engine. Each MUCC website was searched for: presence of a ChatBot, wait time, ability to schedule appointments online, patient checklist, listed treated injuries, and affiliation. ?? Results show that some offered chatbots to aid in triage and patient questions. Very few provided patients with resources to help with triage such as a checklist that informed patients when to go to the ED, and few provided a walk-in wait time estimate. This study could uniquely encourage MUCCs to educate patients regarding the appropriate facility to seek care, allowing EDs to continue providing care for more emergent conditions and true orthopedic emergencies.

Amity High School

Teacher: Catherine Piscitelli

Project # 7

Balamurugan, Vishwa

Effects of Climate Change on Wildfire Severity in the Pacific Southwest From the 1950s to the Near Future

Completed Project, Environmental

The purpose of my research project is to identify the effects of climate change on wildfire severity in the Pacific Southwest from the 1950s to the near future. I hypothesize that due to climate change, there would be an increase in the instances of fires plus their severity at the same time. The reason for my conclusion is that climate change would cause more days of optimal fire formation and cause the buildup of more fuel for them. The method for my project is that I will first go and learn how to code in R for data analysis through Youtube tutorials, and then I will extra the biggest 10 fire perimeters from the FRAP fire perimeter dataset. Using those fire perimeters, I will start the process of data extraction and formating using Google Earth Engine, and after that, I will use R to create histograms and density curves to get probabilities of certain conditions. I will then mark the point when the fire had started, find the probability of that happening, and then interpret it with the effects of climate change included. Soon after, I will start to find a future climate model, and then do the same process I listed above. The results of my project show that my hypothesis has been proven to be correct. The implications of my project are that it will allow for an insight into the current effects of climate change and how the situation would evolve over the next few years.

Amity High School

Teacher: Catherine Piscitelli

Project # 8

Banks, Claire

An Interdisciplinary Analysis of vc1639, Histidine Kinase - A Multifunctional Transduction Enzyme - By Identifying the Conserved Induction Sequences

Completed Project, Health & Medical

As the microbacterial world evolves, the discovery and analysis of proteins and their structure have grown to become a necessary element in understanding the function of bacteria. As a result, many of the newly discovered proteins are left unanalyzed, as is the case with vc1639. *Vibrio cholerae*, an infectious and frequently lethal bacterium, undergoes a process called Quorum Sensing through a series of stages, which allows it to thrive within the human body and spread uncontrollably. The first stage is known as biofilm production, in which bacteria can begin to communicate via autoinducers; the second stage is a growth of the bacterial colony within the biofilm along with an increase in autoinducer density; while the third and final stage is dispersal, in which bacteria are released within the human body. By understanding these stages, one is able to piece together the protein's function and structure using amino acid sequences and bioinformatics such as Basic Local Alignment Search Tool (BLAST), Kyoto Encyclopedia of Genes and Genomes (Kegg), and RCSB, a macromolecule protein structure bank.

Darien High School

Teacher: Guy Pratt

Project # 9

Barnett, Abby

Designing and Testing an Activated Carbon Cloth Storm Drain Filter to Reduce the Prevalence of Phosphates and Nitrates in the Long Island Sound

Completed Project, Environmental

Excess amounts of nutrient pollutants enter storm drains and are directly deposited into the Long Island Sound. These pollutants carry harmful levels of nitrates and phosphates, which cause eutrophication and lead to lower dissolved oxygen levels, also known as hypoxia, which kills fish populations and even entire ecosystems. My research completed in 2020-2021 has shown that the carbon cloth filter uniquely decreases both phosphate and nitrate concentrations, rather than one of the factors of nutrient pollution as seen in other filtering materials. The purpose of this year's work is to replicate my previous findings utilizing a finalized innovative, effective, and efficient prototype of my carbon cloth storm drain filter. It is hypothesized that the filter will reduce both nitrate and phosphate levels. Filter effectiveness is determined by measuring the concentration of the pollutants in the simulated and real stormwater runoff before and after the use of the carbon cloth filter. A reduction of 100% of nitrates was seen in one trial, and the average decrease of nitrate was 62%. Phosphate levels also decreased by an average of 73%. The storm drain filter will be constructed into two separate parts, one containing a mesh attachment to remove harmful debris, only allowing water to pour through, and a second part that contains the carbon cloth which will successfully filter the contaminated water. Nutrient pollution affects thousands of bodies of water across the world and finding a solution to combat nitrate and phosphate overflow will create healthier water for all marine life.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 10

Bernfeld, William

Structural Determination of Novel Non-Canonical Base Pairs and Mismatches

Completed Project, Health & Medical

With the arrival of the SARS-CoV-2 virus and its variants, humanity has suffered the destructive power of a global pandemic, the likes of which have not occurred since 1920. With over 4.5 million COVID-19-related deaths worldwide, the scientific community is rushing to find ways to slow the virus. Although viral tests and vaccines have been widely distributed, many tests yield false results and numerous breakthrough infections are being reported in vaccinated individuals. Thus, we must improve the tools by which we address the pandemic. To address this need, we synthesized a set of four novel nucleobase pairs – two from purines and pyrimidines, and two from pairs of pyrimidines mediated by transition metal ions – to expand the nucleobase language. We used the Python-based Hierarchical ENvironment for Integrated Xtallography (PHENIX), the Crystallographic Object-Oriented Toolkit (COOT), and ChimeraX to form predictive models of our pairs. We then ran simulations to predict their stability. Upon completion, we assembled the pairs in vitro and fitted them with sticky ends to allow for crystalline self-assembly. Through x-ray diffraction, with phasing and refinement, our findings suggest that these novel, unnatural base pairs are indeed stable. The presence of novel pairs, such as those designed herein, allows researchers to design more precise hybridization probes with fewer off-target effects to better monitor SARS-CoV-2. Moreover, with an expanded DNA/RNA language that can stably integrate into known nucleobase sequences, we could design enzymatic binding sites to encode novel amino acids into proteins, thereby developing new antiviral therapeutics.

King School

Teacher: Victoria Schulman

Project # 11

Chen, Cindy

Examining the Relationship Between Big 5 Traits and Changes in Sleep Quality During the COVID-19 Pandemic: Perceived Stress as a Mediator

Completed Project, Behavioral

The COVID-19 pandemic has elevated average stress levels and generally decreased sleep quality. Higher levels of two Big Five traits - extraversion and neuroticism - correlated with more stress during the pandemic and a greater increase in stress since the start of the pandemic. Big Five is the most widely accepted personality model. It includes openness, conscientiousness, extraversion, agreeableness, and neuroticism. The purpose is to examine how perceived stress mediates the relationship between personality traits and changes in sleep quality during the COVID-19 pandemic. The hypothesis was that individuals with higher levels of neuroticism and extraversion would have had greater changes in sleep quality during the pandemic. The independent variable is the participant's personality traits. The dependent variable is the change in sleep quality. The control was sleep quality before the pandemic, which was compared to sleep quality a few months into the pandemic and current sleep quality. Participants completed the Jenkins Sleep Scale, Big Five Inventory, and Perceived Stress Scale for three different points in time. Results thus far are as expected. Poor sleep impairs cognitive function, increases one's likelihood of developing a cardiometabolic disease, and weakens the immune system, so studying the factors that affect sleep is critical to understanding and improving overall health. Exploring how certain personality traits correlate with sleep would allow for greater insight into the causes, leading individuals to address the issue of their sleep with a more personalized and effective approach.

Amity High School

Teacher: Catherine Piscitelli

Project # 12

Chen, Evelyn

Determining if the effect of music on moral judgements is dependent on participants' awareness of the music's purpose

Completed Project, Behavioral

Moral judgements can be influenced by emotions, which can be induced by music. However, the studies on the effects of music on moral judgements don't take into account awareness. If participants were expecting the music to change their emotions, it may have lessened the effects. Participants were sourced from my school and asked to listen to angry music or happy music, read short stories, and rate the morality of the actions in the stories. The aware half were told to rate how much music affected their emotions, like they did in a similar study, while the unaware half were told to guess which instrument was in the music. The problem statement was "Does the effect of music on moral judgements change based on whether the participants are aware of the purpose of the music?". The independent variables were the music and the awareness of emotion. The dependent variables were the harshness of the judgements and the ratings of emotion. It was expected that the unaware group would be more affected by the music than the aware group. Since background music is rarely focused on, people could be more affected by music in real life than they are in existing studies, which could have affected the accuracy of said studies. Background music is growing common, so understanding more about how it affects judgements and decision making is important.

Amity High School

Teacher: Catherine Piscitelli

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Project # 14

Coakley, Emma

The Impact of Covid-19 Pandemic and Restrictions on the Socialization, Stress, and Anxiety of College Student

Completed Project, Behavioral

Analyze the stress, and anxiety levels of college students in response to the Coronavirus Pandemic. In addition, analyze the impact of the pandemic on college students' socialization. This research is done by conducting an online google survey that is distributed to college students. This will allow professionals in the mental health field as well as young adults to understand the impacts that Covid-19 restrictions have had on them and their patients. I believe that students will demonstrate increased stress and anxiety in social situations due to restrictions the pandemic has placed on a person's ability to interact, attend classes and social events, as well as impacts on everyday life.

Ridgefield High School

Teacher: Patrick Hughes

Project # 15

Davenport, Katherine

The Important Roles of a Species' Socioecology and Domestication: A Comparison of Related Species in Communication-Based Tasks

Completed Project, Behavioral

Finding out how the difference in sociology of a species affects performance in communication-based tasks is crucial in understanding how evolutionary domestication has played a role in pack dynamics. By understanding the interaction between members of a species, humans can better observe the effects of evolutionary domestication- specifically when examining the differences between wolves and canines. When carrying out this experiment, I administered the same trial to both wolves and dogs, testing the retrieval speed of a ball in an independent-based task from a testing apparatus. The testing apparatus was located outside in a clear, outdoor area, and made up of two opaque cups: one containing the ball, the other empty. The dyads were then given a communicative cue, either a point or a verbal command towards one of the cups. This tested the species ability to cooperatively figure out a task, following human commands. I hypothesized that canines will significantly outperform the wolves as their experience of domestic evolution allowed them to have far more independent skills. This hypothesis was supported in my research, where the dogs' ability to follow human commands gave them the upper hand. Through this research, scientists can better understand the relationship between evolutionary domestication and sociology, which can be applied to determining the brains' changes through the taming process. Once we understand the changes in canine cognition through evolutionary domestication, scientists can specifically target the skills canines have adapted in order to most efficiently train working canines.

Darien High School

Teacher: David Lewis

Project # 16

Dillon, Taylor

Determining the Accuracy of C-RAD Surface Imaging tool on Residual Shifts In SBRT Lung Cancer Patients

Completed Project, Health & Medical

Surfacing imaging is a technology that allows accurate daily patient positioning and also tracks patient movement during radiation treatments. If the patient shifts at all during treatment, the program can immediately detect it, where x-rays would only be able to detect movement after the radiation fraction has been given. Surfacing imaging, unlike the CBCT technique, does not use any ionization radiation. The purpose of this study was to determine the accuracy of an optical surface imaging tool (C-RAD) used for stereotactic body radiation therapy lung cancer patients (Cone-beam computed tomography, or CBCT). The independent variable was the C-RAD surface imaging tool and the dependent variable was the change measured in residual shifts. The control would be residual shifts that occurred when patients received X-ray imaging. Each patient's physical data and clinical data was recorded using MOSAIQ. The clinical data was used to determine any negative physical changes that may be a result of residual shifts measured. Treatment data was collected from each of these patients, including setup offsets and intrafraction motion. Physical shifts measured in C-RAD and MOSAIQ were compared to see how accurate the C-RAD surface imaging program was. Results showed that C-RAD was more efficient because of its constant imaging technique and lack of radiation.

Amity High School

Teacher: Catherine Piscitelli

Project # 17

Dong, Michael

CanDriS: posterior profiling of cancer-driving sites based on a two-component evolutionary model

Completed Project, Health & Medical

Cancer genomics studies the irregularities in genes that drive the development and growth of cancer in the body. Current cancer genomics databases have collected millions of somatic mutations that remain to be further explored to identify actionable mutations. However, due to the excessive number of mutations unrelated to cancer, the challenge is to identify somatic mutations within cancer databases that are cancer-driven. We developed a new statistical method to calculate the chance of a somatic mutation to be cancer-driven, given that the number of recurrent mutations that occur at the same nucleotide in different cancer patients is not likely a coincidence; often referred to as the posterior possibility in Bayesian statistics. Under the notion that carcinogenesis is a form of somatic-cell evolution, we developed a two-component mixture model: while the ground component corresponds to passenger mutations, the rapidly-evolving component corresponds to driver mutations. We further designed a software CanDriS (Cancer Driver Sites) to profile potential cancer-driver mutations in the Tumor Cancer Genome Atlas (TCGA), which contains over 9000 samples across 33 tumor types. Using this software, we identified that approximately 1% of the sites have posterior probabilities larger than 0.90 and listed potential cancer-wide and cancer-specific driver mutations. CanDriS greatly improves our knowledge of the genetic basis of cancer, and it can become a useful tool to identify targeted genes for study in the up-and-coming era of precision medicine. The results of our research can be viewed in the database CandrisDB (<http://biopharm.zju.edu.cn/candrisdb/>).

Darien High School

Teacher: Christine Leventhal

Project # 18

Donzeiser, Lily

Evolutionary Adaptability of Piranga Olivacea to Climate Change

Completed Project, Environmental

In the 21st century, climate change is threatening the populations of many species with extinction. Because environments are changing rapidly, this leaves many species with the uncertainty that their evolutionary processes may not be able to keep pace. Profound consequences will result from the human population's heavy reliance on the environment, so it is vitally important to protect species. In this study, a migratory species known as the Scarlet Tanager's (*Piranga olivacea*) vulnerability to climate change was assessed in terms of its breeding range and morphological changes. *P. olivacea*'s distribution was analyzed using the Species Distribution Model "Maxent" to project geographical dispersion. Locality data was obtained from the Global Biodiversity Information Facility (GBIF) from 1950-1970 and 2000-2020, and from April-September in North America. The WorldClim database was used for environmental data to assess *P. olivacea* localities with temperature, precipitation, and land cover, all factors impacted by climate change. WorldClim's projection of future climate data between 2061-2080 was used to evaluate the Tanager's future vulnerability. Morphological data from LSU's Museum of Natural Science was utilized to examine any development in *P. olivacea*'s evolution. Measurements such as bill width, Kipp's Index, wing cord., and more signify any attempts to adapt to climate change, or failure to do so. Individuals were used from the late 1880s to late 2010s. It is hypothesized that *Piranga olivacea* will attempt to shift its breeding range and morphologically adapt to changing climatic conditions, but ultimately the species's ability to do so will prove limited.

Darien High School

Teacher: Christine Leventhal

Project # 19

Enters, Alison

The effect of microplastic ingestion on the health of parasites (*Cryptocotyle lingua*) in periwinkles (*Littorina littorea*)

Completed Project, Environmental

Microplastics, plastics smaller than 5 mm, threaten marine life as they are hard to distinguish from food sources such as planktons, and are easily ingestible. Parasites also threaten marine organisms as they make their way between hosts through the food web. For trematodes specifically, it is important that the entire ecosystem is healthy in order for the parasite to complete its life cycle; if microplastics make their way into the food web of a specific ecosystem and impair the health of the organisms in that ecosystem, it may become more difficult for parasites to thrive with a lack of viable hosts. Microplastics have been shown to impair the health of marine organisms, and may prevent parasites from completing their life cycles if there are no healthy hosts to inhabit. Limited research has been done on the interactions between parasites and microplastics. The purpose of this experiment was to determine if microplastic ingestion impacts the health of parasites, *Cryptocotyle lingua*, in periwinkles, *Littorina littorea*. To test this, *L. littorea* infected with the parasite *C. lingua* were fed microplastics adhered to seaweed (*Ulva lactuca*), and the cercarial output of each snail was quantified. This value was compared to the control cercarial output of each snail. The soft body tissues of all *L. littorea* were digested in KOH to confirm microplastic ingestion. No correlation between microplastic ingestion and cercarial output was found after statistical analyses. These inconclusive results suggest the need for further research on the microplastic-parasite relationship and the need for revised methods of testing this relationship.

Darien High School

Teacher: David Lewis

Project # 20

Finn, Regina

Forest Restoration after Wildfire: The Effect of the Addition of Saccharides on Seedling Survival After Replanting in Burnt Soil

Completed Project, Environmental

Forest Fires are a threat to wildlife, leading to lasting changes in ecosystems by burning trees and affecting soils' water retention properties. As seedlings require moist soil, a solution is crucial to survival, especially for trees that are fire-sensitive, such as sugar maples. It is hypothesized that introducing saccharide solution to burnt soil will improve water retention and subsequently increase the survival of seedlings. This study aims to determine 1) the effects of adding simple glucose on trees suited for drier climates and 2) the effects of adding saccharide solution on trees not naturally affected by fires. In phase one, eight boxwood (*Buxus sempervirens*) seedlings were individually planted in 300ml of heated soil indoors and treated with three different quantities of glucose either once or repeatedly. Survival was determined by signs of dehydration in leaves through color and texture. Part 2 investigated the effect of the addition of maple water to sugar maple (*Acer saccharum*) seedling survival after planting in burned soil outside. The addition of 3.50 grams of glucose to boxwood seedlings was associated with the longest survival time of 5 weeks. The addition of the 7.50 g dosage of maple water to sugar maple was associated with the longest survival, indicating the benefit of higher levels of saccharides and other helpful nutrients to aid in sugar maples' survival. In conclusion, the results of this study suggests that addition of a saccharide solution can aid in the regrowth of forest ecosystems.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 21

Gouveia, Camryn

Walk on shoe

Completed Project, Physical Science

The objective for my engineering project is making a shoe that will not only save time but it will be more comfortable than any other shoe you have worn, because of the soft material that will in case your foot it will make walking feel effortless, and by having a more compact design you will be able to store my shoe practically anywhere because the mesh that wraps around you foot will shrink down over the shoe when you decide to take them off. The First step is the design or mock of what the shoe will eventually hopefully look like. After creating the shoe step two is finding the dimensions of the parts used for the shoe which will consequently involve more drawing and research to figure out what measurement the parts should be. For example the first measurement would be the millimeters in length and with of a standard American 11/5 shoe, we will need those lengths to than determine the lengths of the extruding features on the shoe. During the procedure of making the shoe there will be testing of one child under the age of 18 and no testing of adults. After we make the first drawn out drafts of the shoe the next step would be to figure out the forms to fill out in order to make the real version of the shoe which we will be calling mock up 1.

Newtown High School

Teacher: Timothy DeJulio

Project # 22

Gross, Ava

Comparing Bone Integration in Dental Implants in Patients Based on Age, Sex, and Pre-Existing Conditions

Completed Project, Health & Medical

Missing teeth can cause jaw bone deterioration, ineffective mastication, shift in facial appearance, gastrointestinal issues, and can affect speech. Every year, 5 million implants are placed and are shown to drastically improve quality of life. However, doctors usually advise patients with pre-existing conditions such as diabetes, periodontitis, and heart disease to avoid getting dental implants and opting for an easier, yet less effective route, of dental care through bridges or dentures. The purpose of this project is to investigate whether pre-existing conditions, age or sex actually affect the percentage of bone loss after placement in dental implants. If bone loss from patients with pre-existing conditions is compared against bone loss from patients without pre-existing conditions, then the data will show that the presence of a pre-existing condition affects the percentage of bone loss. In this experiment, the independent variable is the pre-existing condition, age, or sex and the dependent variable is the percentage of bone loss. The patient data without a pre-existing condition will be the control because it is considered the ideal situation for a dental implant. The student's mentor, Dr. Duplinsky, provided the unnamed patient files. Within the files of the unnamed patient data used in prior years, there is a note concerning pre-existing health conditions, age, and sex. Once all of the patients with conditions are noted, the student separated them into categories depending on condition- periodontitis, diabetes, or heart disease. From there they were further separated into groups based on the period of time the dental implant has been in the patient's mouth. This data was compared against a similar group, but the patient had no pre-existing condition (control group). After each comparison, the group with the higher percentage of bone loss was noted. The student completed all data collection, data organization, and data analysis. The mentor oversaw and provided guidance, but did no hands-on work. The data analysis was done through StatCrunch. This was completed to see if the difference between percentage of bone loss in patients with pre-existing conditions and without pre-existing conditions is significant. So far, data trends suggest that sex played no factor in percentage of bone loss. The conclusions from this project will help indicate if pre-existing conditions, age or sex actually play a role in percentage of bone loss over time in dental implants. In turn, it will help inform periodontists, oral maxillofacial surgeons, and general dentists so they can prescribe the best course of care for their patients.

Amity High School

Teacher: Catherine Piscitelli

Project # 23

Grosso, Nicole

Determining the Impact of Various Social Factors on Community Resilience Following Wildfires

Completed Project, Environmental

Over the past decade, the severity and frequency of wildfires have increased by a drastic amount. The smoke produced by wildfires has been linked to numerous health issues, such as Chronic Obstructive Pulmonary Disease (COPD), which causes airflow blockage and other breathing-related issues. Different communities have varying levels of resilience when these wildfires occur, meaning that they can recover to have the capability to grow once more following the end of the wildfire. The purpose of this project was to determine the impact of various social factors on the resilience of a community following a wildfire. The independent variable in this project was the amount of infrastructure in a community that relates to social factors, and the dependent variable was the resilience of the community. In order to determine whether or not the hypothesis was supported, the student viewed US census data of different communities in California that have suffered from the same wildfires. Census data regarding social capital, education, financial structures, and language were taken into account from the year before the fire and analyzed in conjunction with data from the months and years following. This was used to determine the resilience of each community following the same timeline within various aspects relating to social resilience. The more resilient an environment is, its future recovery will be quicker than that of a less resilient environment when impacted by wildfires. Determining social factors that help with community resilience following these fires will greatly aid in strengthening wildfire response.

Amity High School

Teacher: Catherine Piscitelli

Project # 24

Gu, Emily

Effects of Cannabinoids on Verbal Learning and Memory: Relationship to Biological Sex

Completed Project, Health & Medical

Cannabinoid effects include acute and long-term impacts on cognition, especially in verbal learning deficits. Men and women may experience cannabinoid effects differently, but biological sex differences in cannabinoid-induced verbal learning deficits are not well-categorized. Delta-9-tetrahydrocannabinol (THC), the principal psychoactive constituent of cannabis, produces verbal learning deficits acutely similar to herbal cannabis and can be used to model the acute effects of cannabis in human laboratory studies. A man-made version of THC, dronabinol, was used, avoiding the potency variability in herbal cannabis products as well as the effect of other cannabinoids in plant material. The purpose of this project was to examine the acute verbal learning deficits induced by oral THC in healthy humans and analyze sex-related differences in this response. The hypothesis was that THC will acutely induce verbal learning deficits measured using the Rey's Auditory Verbal Learning Task (RAVLT) compared to placebo and this deficit was influenced by the biological sex of the participants. The IV was the drug condition and the biological sex of participants. The DV was the RAVLT results. The student's role was to analyze, interpret, and present data from a double-blind randomized placebo-controlled human laboratory study in healthy individuals conducted by the mentors. Data was analyzed using ANOVAs and t-tests. The data trends currently support the hypothesis. With edible cannabis products being increasingly available to young adults, it is important to characterize the acute cognitive effects associated with them as well as how biological sex affects the effects.

Amity High School

Teacher: Catherine Piscitelli

Project # 25

He, Zongyao

Comparing the efficiency of synthetic organism (designed from different computation algorithms)

Research Proposal, Physical Science

In modern society, people cherish the prosperity science has brought over the past few decades, but at the same time, most of them are unaware of the deteriorating side effect of the previously mentioned benefit had brought to the environment around them. Therefore, it is important to begin introducing bio compatible technologies for a greener world. One of the most befitting topics for a more economical world would be artificial organisms, or more commonly known as BioBots; robots on the cellular level that can achieve desirable functions such as intelligent drug delivery, and internal surgery through AI designs. Currently, there are many different proposals for the creation of biobots, two of which would be modification by refactored genomes and synthetic organoids. However, both methods lack direct control, or predictability of the end result, therefore, the design of biobots are first completed through computer simulations, or silico, using an evolutionary algorithm. The predicted result is likely dictated by the environment in which the condition of the computer is exposed to in a simulation, therefore, it would be the priority to take account of specific elements within the simulation to produce desired results/functions from the composed biobot. Once the desired result is achieved, it is likely biobot would open the doorway to a more off hand and convenient way of genetic engineering, or bioengineering in the broader spectrum.

Darien High School

Teacher: Christine Leventhal

Project # 26

Irshad, Suhail

Determining the Causes of Failure of Cephalomedullary Nails on a Proximal Femoral Fracture Based on Stress and Strain on the Implant and Proximal Femur.

Completed Project, Health & Medical

The fracturing of the proximal femur, a bone located in the hip region, is an injury mostly in older people. Many existing implants to fix these fractures already exist, including cephalomedullary nails. However, there are chances of implant failure based on the stress and strain on the implant and femur. Purpose of study was to analyze why cephalomedullary nails would fail in fixing a proximal femoral fracture. Hypothesis was that the cephalomedullary nails would fail to fix the fracture because it would cause high stress and strain on implant and femur. Independent variable was the load amount on the implant and femur. Dependent variables were areas of stress and strain on implant and femur. No control was present because project focused on the causes of failure for specifically the cephalomedullary nail. Implant was built in CAD software called SolidWorks. Model was created from DICOM images provided by mentor in an image processing software called Scan IP and then converted to a 3D mesh with a fracture. Then, different loading amounts were ran on the model. Areas of peak stress, peak strain, and displacement of implant was measured during the scenarios. Simulations and the measurements was done using Finite Element Analysis software called Abaqus. Mentor provided access to software. Data gained could be used to redesign the implant to reduce areas of stress, concentrations, and displacement. Same testing methods can be used on new implant for failure analysis.

Amity High School

Teacher: Catherine Piscitelli

Project # 27

Jones, Ryan

Blast-based Characterization of Protein Drug Targets in Protozoan Parasites

Completed Project, Health & Medical

This experiment examines the secondary structure in several protein drug target candidates for a variety of parasitic protozoa. The selected proteins have little known information regarding their three-dimensional structure and function, however, their amino acid sequence can indicate much about both their structure and potential function. The selected unknown proteins were Plasmodium falciparum serine-repeat antigen 5 (PfSERA5), Trypanosoma brucei metacaspase 3 (TbMCA3), and Toxoplasma gondii doublecortin domain-containing protein (TgDCX). What is shown in previous research about these proteins, is that they are likely involved in the protein quality control. By comparing the composition of these unknown proteins to structures stored in the BLASTp database, similar known proteins may become apparent. Once similar proteins were identified, Clustal sequence alignment allowed for comparison of identity and similarity in specific regions of the proteins to identify potential binding sites and critical structural components of the unknown proteins. Orthologous proteins or proteins with similar secondary structure in sections may be able to outline the specificity or indicate potential experiments that can be conducted to further the understanding of these unknown proteins. A few orthologous and similar proteins were found during experimentation, potential functions and structures were identified and much future work was proposed. An extremely important facet of this experiment was that many of these unknown proteins contain orthologs in relative species of these protozoan parasites, so the work found in this experiment can be tested on these related parasites, too.

Darien High School

Teacher: Guy Pratt

Project # 28

Kolb, Antonia

A Convolutional Neural Network for Real-Time Tick Classification and Disease Risk Analysis

Completed Project, Health & Medical

There is an alarming increase in the population of ticks and the tick-borne diseases (TBDs) they transmit, some of which are fatal. Due to limited training, healthcare providers cannot always accurately identify ticks and their associated illnesses, leading to delayed diagnoses and treatments. There is also little correlation between tick species and the particular TBDs they may carry because the prevalence rates of different disease-causing pathogens vary based on geographic location within the USA. Using transfer learning, a convolutional neural network (CNN) was built for real-time tick species identification and embedded tick risk assessment using the Tick Lab of Pennsylvania's location-based tick surveillance statistics. The CNN was able to accurately identify three tick species: *Ixodes scapularis* (Eastern blacklegged tick), *Amblyomma americanum* (Lone star tick), and *Dermacentor variabilis* (American dog tick). The overall performance of the model was 80%, and the specific accuracy rates for *I. scapularis*, *A. americanum*, and *D. variabilis* identification were 78%, 70%, and 75%, respectively. With this, users will have more accurate, conclusive analyses of their risks of contracting certain TBDs, which will be useful nation-wide in helping tick-bite victims identify the need to seek medical assistance, particularly for those with underlying conditions.

King School

Teacher: Victoria Schulman

Project # 29

Krauss, Rachel

The Analyzation of Immune System Genes from Ancient Human DNA to Modern Human DNA.

Research Proposal, Health & Medical

How do patterns in mutations and DNA changes from ancient Homosapien DNA to modern human DNA help scientists identify a new potential way of looking at human diseases? Tracking DNA patterns from ancient humans to modern humans help create a deeper understanding of immune response to infectious disease in the modern human body. The current record of the human genome databases will be used as a resource. The first step will be to identify the genes that are involved in infectious disease responses. The genes recorded from the human genome are going to be the endpoint of the human gene timeline created. DNA from a wide range of points in human history from the earliest homosapiens to closer dates in history would then be collected from databases and articles and create a timeline of the same few gene pieces. Once the data is identified, it will be analyzed to see if any patterns of mutations arose throughout history from the oldest DNA set to the youngest. This will be done through the BLAST program to find homologous pairs and patterns in the genes that have been collected. The methods in the BLAST program will be but not limited to the Need-Wuncsh Alignment. Once the patterns have been located, they will be further examined. This time to look and see if a more detailed conclusion is obtainable on how humans and our ancestors have dealt with infectious disease has led to the way modern humans now naturally fight infectious disease.

Newtown High School

Teacher: Timothy DeJulio

Project # 30

Krishnan, Gouri

Electrochromism paired with Finite Difference Time Domain Modeling allows for the Successful Prediction of Color Change Achieved by Electrochromic Reactions

Completed Project, Environmental

With more than 60% of energy used for energy generation lost, the issue of how to save energy has come to the forefront of research in recent years, particularly as greenhouse gas emissions from wasted energy continue to increase the effects of global warming and climate change. New and innovative approaches are needed to solve this problem; energy saving electrochromic windows fulfill this need. We aimed to improve existing electrochromic windows by designing a more efficient electrochromic coating that can undergo a reversible color change when exposed to smaller magnitudes of positive and negative applied potentials. We ran simulations with varied parameters using the Lumerical modeling software to achieve the best fit between reflectance spectrums generated by simulations and reflectance spectrums obtained from in-person experimentation. Furthermore, additional software was used to acquire an RGB color value from the simulation-generated reflectance spectrums, providing insight into the ideal thicknesses and material combinations necessary to achieve the desired color change. We found that a two-layer model with a top layer of TiCrOx with a thickness of 176 nm and a bottom layer of fluorine-doped SnOx with a thickness of 600 nm allowed for the best fit with the experimental results. Collectively, these novel conditions identified herein lay the groundwork for designing an efficient electrochromic coating and window, a promising solution to a problem that has eluded researchers for years. This, in turn, will allow for an increase in energy savings worldwide, and, most importantly, a decrease in carbon emissions, thereby mitigating climate change.

King School

Teacher: Victoria Schulman

Project # 31

Kulkarni, Avani

Bioinformatic identification of microRNAs that post-transcriptionally regulate host gene CCR5

Completed Project, Health & Medical

In order to infect cells, human immunodeficiency virus type 1 (HIV) uses the gene CCR5 as a co-receptor (a gene that can bind a signaling molecule like HIV), which is expressed on the cell surface of certain immune cells. HIV binds to CCR5, which allows for the virus cell entry and infection. The CCR5 gene has a very long 3' untranslated region or UTR that influences gene expression. In general microRNAs, fragments of an RNA strand that prevent the production of a protein, control gene expression post-transcriptionally. Therefore, it is possible that this long 3'-UTR binds microRNAs, which may reduce CCR5 gene expression. If so, that may negatively impact HIV's ability to infect immune cells because without CCR5 expression, HIV cannot enter the cell. The purpose of this study was to determine which specific microRNAs can post-transcriptionally regulate CCR5. The independent variable was the specific microRNA, and the dependent variable was CCR5 gene expression. To conduct this study, several online tools were used to identify microRNA binding sites on mRNA transcripts. This allowed identification of microRNAs that could potentially regulate CCR5. The data from these programs was cross-referenced to narrow down the possible microRNAs based on reliability for experimental validation. Findings suggest a microRNA that regulates CCR5 expression is miR-125-5p. If microRNAs that regulate post-transcriptional gene expression of CCR5 are found, that may be extremely helpful in terms of the HIV 'cure' effort, since disruption of CCR5 gene expression is a major target of scientists throughout the world.

Amity High School

Teacher: Catherine Piscitelli

Project # 32

Lapierre, Lucca

Bird Image Recognition Using Pytorch

Completed Project, Physical Science

Bird watching is a popular hobby among many but being able to identify birds out in the field or from a picture can be challenging for those with less experience. Apps have been made to solve this issue such as Merlin Bird ID, an app that allows users to upload a photo of a bird and then uses image recognition algorithms to identify the bird. Many of these applications use convolution neural networks(CNNs) which is a branch of machine and deep learning. These networks detect features like lines, edges, or curves in a given image and then make predictions on new images using the features it has detected. The goal of this project is to use the Caltech-UCSD Birds-200-2011 dataset, which has 200 bird species spread across 11,788 images and publicly available code written by Sasank Chilamkurthy that was made for ant and bee identification to create a neural network model that can correctly identify the birds within the dataset at an accuracy of 90 or higher. Changes to the code will have to be made to allow it to use the previously mentioned dataset . Once all the images from the dataset have been correctly identified and a final accuracy has been reached research will begin into finding a method to use this model in conjunction with a wireless camera attached to a bird feeder to provide a non-invasive way of viewing birds in the wild.

Newtown High School

Teacher: Timothy DeJulio

Project # 33

Li, Matthew

The effect of position played in high school American Football on the number of impacts sustained to the head

Completed Project, Health & Medical

The number of concussions a person undergoes has been shown to directly correlate with an increase in depression and mental illness. Every year in the U.S. around 1.6 million concussions are a result of participation in sports. Anywhere from 3.6% to 5.6% of the 1.2 million high school football players will suffer a concussion. However, even though the vast majority of football concussions occur in high school football, most concussion research is directed towards college and NFL football players. This project aimed to quantify the number of head impacts that different high school football players went through in a season. The hypothesis was that if hits were to be recorded throughout high school football games, then linemen would endure the most impacts to the head. The independent variable was the position played. The dependent variable was the number of impacts that he sustained to the head. There was no control as this was a comparison project. Data was collected through film reviews of football games. The data was analyzed to see if position played has an effect on head impacts received. Thus far, data trends show the hypothesis to be correct. If successful, the research could be used in the future to inform potential rule changes to be made for football high school football as well as provide information for helmet designers dedicated to high school athletes.

Amity High School

Teacher: Catherine Piscitelli

Project # 34

Liu, Adam

Utilizing Simulations to Create Carbon Reduction Models

Research Proposal, Environmental

The world has become more reliant on technology, and as a result, there has been an increase in carbon emissions. The most prominent problem with this is climate change. Several approaches for reducing carbon emissions have been deployed, but carbon neutrality is still far out of reach. In this project, a computational model will be created for carbon reduction in Connecticut, contributing to the broader goal of netting zero emissions nationally. This experiment will utilize a bottom-up approach so major sectors of energy consumption in Connecticut will be included in the model. A techno-economic analysis will be done on carbon emitters in each sector with the System Advisor Model (SAM). SAM will be utilized in order to facilitate decisions for the renewable energy technologies applied in the model by generating data on the cost and effectiveness of these decisions. The data will then be analyzed and compared to data gathered from a collaborative partner taking a top-down approach. This will then be applied to the carbon reduction model. The model's effectiveness will be determined by comparing its cost and level of carbon reduction to other existing models. In addition to this, the societal adoption of this model will also be factored into the effectiveness of the model. The implications of this model include setting up a framework that can reduce carbon emissions locally and be scaled to fit other regions. This would aid in eliminating the harms of carbon emissions.

Amity High School

Teacher: Catherine Piscitelli

Project # 35

Liu, Sophia

Determining Position Preference of Different Species of Insect Galls in Relation to Each Other on the *Solidago altissima*

Completed Project, Environmental

Galls are abnormal growths created by plants and induced by other organisms, providing nutrients and shelter for inhabitants. Two common insect galls on the goldenrod plant (*Solidago altissima*) are the ball gall (created by *Eurosta solidaginis*) and the bunch gall (created by *Rhopalomyia solidaginis*). Little is known about the relationship/distribution of these two galling species at a field scale. The purpose of this project was to determine if the position of these galls are negatively, positively, or neutrally associated with each other. I hypothesized that goldenrod galling insects are positively associated with each other. The independent variable was the relative location of the galls, and the dependent variable is the overlap of the galls in a field. First, I estimated the area of the field and the number of plants/galls. Second, I created an image/map of the galls by randomly sampling the field of goldenrod, recording the locations, and creating a digital map of the two species. Third, I created a digital map of the field/galls assuming neutral association. Fourth, I ran various statistical tests such as T-tests and ANOVA to compare the hypothetical neutral association graph and the graph of the actual field to determine association in the actual field. Data trends thus far have not supported the hypothesis. Understanding the co-occurrence of galls can provide insight into the tendencies of galling insects to inform studies using galling insects as biological control agents and studies attempting to minimize the damage of galls.

Amity High School

Teacher: Catherine Piscitelli

Project # 36

Liu, Yuqi

Analyzing the Effect of Toneless Language Acquisition on Tone Discrimination and Production Observed in Mandarin Chinese Native and English Nonnative Speakers

Completed Project, Behavioral

Mandarin Chinese is a tonal language, meaning that tone is a crucial suprasegmental component for proper language expression; contrastively, English is a non-tonal language. Past studies have shown tonal language acquisition makes children more receptive towards picking up on tone, while the acquisition of a toneless language makes children less receptive. The purpose of this study is to examine if and how acquiring a toneless language after previous acquisition of a tonal language affects tone discrimination and production. The hypothesis is that those with greater exposure to a toneless language will have decreased tone discrimination and production despite having learned a tonal language prior. The independent variable is years of exposure to a toneless language (English), the dependent variable is the tone discrimination and production of the individual (in Mandarin Chinese), and the controls in this study are participants with no exposure in a toneless language, or English-only speakers. Participants will provide a speech sample and identify rising, falling, high, low, and neutral tones in a pre-recorded audio. Tone production is measured by pitch contrast and contour in the participant's speech, which the mentee will analyze using phonetics analysis software, and tone discrimination will be measured by the participant's accuracy in tone identification. The results will be plotted against the participant's years of English exposure and graphed to determine correlation between years of English exposure and tone discrimination or production. The broader implications of this study include providing greater understanding into how toneless language acquisition affects tone discrimination and production.

Amity High School

Teacher: Catherine Piscitelli

Project # 37

Lu, Melinda

In Vivo Imaging of Structural Connectivity and Synaptic Density in Alzheimer's Disease

Completed Project, Health & Medical

Alzheimer's disease (AD) has been considered a pathology of the gray matter (GM) with both hallmarks of the disease, amyloid-beta and tau buildup, contributing to neurodegeneration, or GM loss. However, recent studies have indicated that white matter (WM) damage found in early stages of AD may contribute to disease progression. This study aimed to bridge the gap between WM tract damage and corresponding synaptic damage in GM regions in AD. It was hypothesized that WM tract damage is associated with synaptic loss in GM and that this relationship would be strongest in medial temporal regions that are affected early in AD. The IV was WM tract integrity, which was measured using diffusion tensor imaging (DTI). The DV was synaptic density, measured using positron emission tomography (PET) to quantify synaptic tracer, [11C]UCB-J, binding to synaptic markers, synaptic vesicles glycoprotein 2A (SV2A). Analysis was performed in a group of AD individuals with early dementia and mild cognitive impairment. The DTI and PET imaging data came from studies done at Yale's Alzheimer's Disease Research Unit. Preprocessing of the DTI images through FreeSurfer, DSI Studio, and 3D Slicer software was performed to create diffusion tensor models. The relationship between the WM integrity and synaptic density was analyzed using linear models which showed a significant correlation between WM DTI measures of axial and mean diffusivity across both brain hemispheres and the synaptic density in regions that subserve their respective WM tracts. These findings provide new insights on how WM integrity changes affect AD neurobiology.

Amity High School

Teacher: Catherine Piscitelli

Project # 38

Lucian, Hannah

Track System for Safe and Effective Lifeboat Launches

Completed Project, Physical Science

I will begin with purchasing a model track (non translucent) and conduct various measurements on the object. Using these measurements I will sketch several blueprints of possible prototypes for the wheel and support structure or bar that would be used to connect the lifeboat to the track for easy release and to properly scale. I will 3D print the models in which I sketch after importing them into a computer program for the proper measurements to be implemented. Once these are printed, I will compare them against the model track to compare accuracy of the print measurements and how efficiently they can scale the track. I will work to determine the best model and make any edits if necessary. I will focus on perfecting that particular wheel and support model and conduct further tests on its ability to efficiently scale the model track. Once an efficient model is found, I will begin researching ways to connect the wheel and support to the lifeboat itself. This will take a great deal of further research that will include several different articles and potentially input from marine colleges and institutions.

Newtown High School

Teacher: Timothy DeJulio

Project # 39

Marin, Audrey

Using Ingenuity Pathway Analysis (IPA) to Analyze Mutant and Wildtype KRAS Colorectal Cancer Cells grown as 3D Organoids

Completed Project, Health & Medical

The purpose was to determine whether the KRAS mutation impacts cellular connections to female estrogen receptors and secondarily analyze whether analyzing cells grown as 3D organoids differs from the 2D cell line model. My mentor grew the Colorectal Cancer cell 3D organoids and 2D cell lines, ultimately collecting RNA-Sequencing Data. I worked from home, deciphering this data utilizing Ingenuity Pathway Analysis (IPA) software. Results thus far demonstrate expected correlation to female estrogen receptors.

Amity High School

Teacher: Catherine Piscitelli

Project # 40

Meier, Stella

Selection of High-Affinity scFv for HPRT by Yeast Surface Display

Completed Project, Health & Medical

Cancer is the second leading cause of death in the world. Common treatments against cancer include chemotherapy and radiation, which are highly invasive and have many negative side effects. Previous studies have shown the effectiveness of immunotherapy, an up-and-coming, non-invasive cancer treatment, to reduce tumor size, kill cancer cells, and limit side effects. In addition, studies identify HPRT, an antigen expressed only on cancerous cells, as a potential target for an scFv antibody immunotherapy treatment which is easier to genetically engineer and travel through the bloodstream than a monoclonal antibody treatment. The purpose of the completed experiment was to select scFvs with a high-binding affinity for HPRT in order to create a HPRT antibody-mediated immunotherapy treatment to incite an immune response against cancer. Yeast surface display was used to select the high-affinity scFv by treating a yeast library expressing a multitude of scFvs with HPRT and using MAC and FAC sorting. The yeast cells expressing scFvs with high-binding affinity to HPRT were selected and analyzed with clonal selection. After selection, an affinity binding curve is measured for each unique clone to identify an scFv with the highest affinity. Two clones were selected with scFvs that have a high binding affinity thus supporting the hypothesis. The experiment will continue to identify other clones with high binding affinity in order to isolate the scFvs and use them to create a CAR-T cell treatment.

Darien High School

Teacher: David Lewis

Project # 41

Mengwall, Sebastian

Cloud Identification in Mars Daily Global Maps with Deep Learning

Completed Project, Physical Science

Cloud identification on Mars is an important tool for climatology studies, making it possible to analyze the distribution, patterns and variability of clouds both spatially and temporally. Traditionally, cloud data on Mars has been extracted through manual or semi-automated processes, resulting in limited spatial and temporal coverage. In this paper we demonstrate the successful use of convolutional neural networks (CNNs) to extract cloud masks from Mars Daily Global Maps (MDGMs) composed from the Mars Color Imager on the Mars Reconnaissance Orbiter. The fully automated model reports 97% pixel-wise accuracy compared to the testing dataset, and in many occasions the model performs better at extracting the full extent of the cloud compared to the prior semi-automatic technique. We also introduce several pre and post-processing image techniques to improve the model's performance and usability. The model is configured to provide cloud masks at 0.1 degree longitude by 0.1 degree latitude resolution. It also automatically bounds the MDGM by northern and southern polar extents depending on solar longitude. The results suggest that our deep learning model is a useful tool to automatically and quickly extract Martian water ice cloud masks and make it possible to generate cloud mask data across the complete set of MDGMs. The model and related techniques also have potential extensions to Martian dust storm identification. We will make our code, model, and data publicly available

Darien High School

Teacher: David Lewis

Project # 42

Novak, Eric

The expression of specific genomes -Specifically Shh(Sonic Hedgehog) RNA codes- are associated with the regenerative ability of the limb cells

Completed Project, Health & Medical

The Mexican Axolotl is one of the few animals that has the ability to regenerate its vital body parts. A blastema is a group of reserve muscle and tissue cells that would act similarly to an embryo to regenerate a limb. To remove the regenerative ability of the blastema you need to sever the brachial nerve to cut positional communication and awareness in the amputated limb. The purpose of this research was to determine if the expression of specific genomes -Specifically Shh(Sonic Hedgehog) RNA codes- are associated with the regenerative ability of the limb cells. My hypothesis was that the expression of regenerative genes would not occur when the regenerative ability is removed from the blastema. The independent variable of this project was the removal of regenerative ability of limb cells. The dependent variable was how much of Shh RNA was expressed when regenerative ability is removed. To start the regenerative process the mentor will perform an ALM surgery. The nerve was severed to render the blastema incompetent, and tissue was collected for molecular analysis 3 days following denervation. The mentor then performed q-RTPCR Along with my mentor I analyzed the q-RTPCR data to determine whether Shh expression was maintained in the ALM blastemas post denervation. Results thus far show that the Shh gene is not related to the regenerative process of the Axolotl. This study helps us determine whether Shh expression is associated with regenerative ability and will get us closer to understanding how regeneration occurs.

Amity High School

Teacher: Catherine Piscitelli

Project # 43

O'Connor, Colby

Examining The Relationship Between Physical Activity and The Competitive Nature of High School Students

Completed Project, Behavioral

The purpose of this project was to determine the effect physical activity played on the competitive nature of high school students. For this study a survey was sent to consented high school participants. This survey asked for the participant's demographics, whether they play sports, what sport(s), whether they have a gym membership, the amount of physical activity they have participated in within the past week, month, and year, the average duration of one physical activity, and a combination of twenty self-selected questions taken from the Hypercompetitive Attitude Scale, the Personal Development Attitude Scale, and the SOQ Competitiveness scale. Furthermore, the questions were chosen to gauge the participant's level of competitiveness. These questions were answered on a likert scale. The participant's mean score of these questions was their overall mean competitiveness scores. The overall mean competitiveness scores were compared to the frequencies of physical activity and specific activities of the participants through regression analyses, and t-tests. Data trends thus far suggest that there are mild differences between competitive natures of those who play sports versus those who don't, low differences between those with a gym membership versus those without, high differences between those who have high frequency physical activity versus those who do not, and high differences between those who started sports before elementary school vs those who start after elementary school. This project suggests that participating in physical activity may play an important role for a high school person in developing positive character attributes.

Amity High School

Teacher: Catherine Piscitelli

Project # 44

O'Connor, Annie

Using NYC Parks Department "Report a Sighting" Data to Investigate the Relationship Between Emotional Response to Wildlife and Borough and Uncover Instances of Environmental Racism in New York City

Completed Project, Environmental

The "Report a Sightings" reports are used to track and collect public sighting reports of healthy wildlife throughout NYC. Although New York City is abundant with parks, research such as a recent report from the Hispanic Access Foundation and the Center for American Progress shows that "communities of color are almost three times more likely than white communities to live in 'nature deprived' areas" (Rowland-Shea et. al, 2020). My research project aims to discover trends in the Report a Sighting data which may support the hypothesis that communities of color are less likely to experience connections to urban wildlife as a hobby or interest in their neighborhoods. Research will begin by classifying each entry in the data set as a "positive" or "negative" emotional response. Next, emotional response will be broken down by borough, to see which borough had the greatest ratio of negative responses to total responses. It is expected that the boroughs with the largest vulnerable populations will have a greater ratio of negative responses to wildlife due to limited access to parks and recreational parkland. If this hypothesis is supported, then instances of environmental racism may be uncovered. The results of this study may impel wildlife scientists to investigate potential ways to make wildlife more accessible and enjoyable for vulnerable populations in NYC.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 45

Ochs, Benjamin

Modular Robotic System for Multipurpose Robots

Completed Project, Physical Science

A possible solution to a modular robot will be designed and developed. A small scale, 3D printed prototype will be built. It would use very similar electronics to a proper, fully-functional robot, but it will only have basic functionality as its primary goal is to demonstrate modularity. To connect the modules of the robot the primary plug will be a DB15 plug. This will carry all data and power to the modules. To test the effectiveness of this solution, a mock robotic system will be constructed. Initially, a core will be built to host the core computer and power systems. This core will have four DB15 connectors, and therefore should be able to support 4 modules at a time. The modules used to test will be a mock part, a simple motor, distance sensor, wheel, light sensor, and any others needed to test certain aspects. These modules should be able to plug into any port on the core and function without issue. The core computer will have to be able to recognize and control each module's computer from every port, and that a module can be switched while it is powered off and recognize the change as soon as it is powered on. If this is successful this will lead the way for this technology to be implemented into a more complex robotic system.

Newtown High School

Teacher: Timothy DeJulio

Project # 46

Persily, Benjamin

The Use of Prime Editing to Induce the CFTR-F508del mutation in iPSCs

Completed Project, Health & Medical

According to the Cystic Fibrosis (CF) Foundation, over 70,000 people across the globe suffer from CF, and the life expectancy of patients with CF drops to about the age of 47. CF is an inherited condition that makes a patient's mucus thicker and stickier, which can lead to lung damage and infection. Approximately, 70-90% of these cases are caused by a 3-bp deletion known as CFTR-F508del. Given the critical need for novel therapeutic interventions with greater efficacy, we aimed to model this mutation using prime editing and iPSCs to later differentiate and use these cells as models for studying CF. iPSCs serve as excellent models for disorders that affect different parts of the patient's body, due to their pluripotency. Prime editing serves as a powerful genetic editing alternative to the more traditional CRISPR/Cas9 method, as prime editing is safer and more reliable. Here, we report the successful reprogramming of fibroblasts into iPSCs and cloning of the pegRNAs required for prime editing. We also attempted to use prime editing to introduce this mutation with the goal of creating CFTR-F508del model cell lines for future study. Our progress to date centers on optimizing the sgRNA component necessary to direct the introduction of the F508del mutation to the target site. Successful demonstration of prime editing in iPSCs holds great potential for studying CF, a disorder that affects a wide range of organs, as well as for future use in clinical applications to bring a better quality of life to CF patients.

King School

Teacher: Victoria Schulman

Project # 47

Pistone, Olivia

Comparing Dendritic Development in Embryonic Neurons Harvested From DDX3X Mutant Mice And Wild Type Mice

Completed Project, Health & Medical

DDX3X syndrome is a rare neurological disorder that affects 3% of females around the world. The syndrome was discovered in 2015, so the molecular functions remain unclear. It occurs when one of the two copies of the DDX3X gene has lost its normal function, due to a mutation. The study will compare neurons harvested from wild-type mice and mice with the mutated DDX3X gene. The neurons from the mutated DDX3X mice will have an altered and simplified structure. In this study, flox P sites were inserted into the mice and the flox heterozygous female mice and wild type cre mice were bred. The cre will recognize the flox and will remove part of the DDX3X gene after breeding, creating haploinsufficient mice. After 15 days, the mice were sacrificed and the embryonic neurons were harvested, and cultured for 14 days. The neurons were then transfected with fluorescent dye, and images were taken of the neurons. The neurons were analyzed by tracing the dendrites to observe the difference of complexity between wild type and mutated neurons. It was expected that the structure of the mutated neuron would be smaller and less complex than the wild-type neurons. This is because the DDX3X gene controls neuron development by regulating the branching of dendrites, so if there is a mutation in the gene, then developmental setbacks will occur. After analysis, the hypothesis that the structure of a mutated neuron will be altered and less developed was supported.

Darien High School

Teacher: Christine Leventhal

Project # 48

Poddar, Aanchal

Designing an AI Which Classifies Audio Based on the Perceived Emotion

Completed Project, Physical Science

Sentiment analysis is the detection and classification of emotions, typically in texts. An extension of this field is speech emotion recognition (SER), which applies similar techniques to audio. This benefits call centers and other human interaction based jobs. Typically, this is done by utilizing Artificial Intelligence. However, research as to what AIs are best is limited. The aim of this project is to design an AI which classifies audio based on the perceived emotion. The model must accurately detect emotion in speech and take the least processing time compared to the other models. This will be done in Python and using the dataset "CREMA-D", which contains 7,442 samples with 6 emotions and 4 intensity levels. First, feature extraction will be performed using librosa on the data to determine the most useful spectral features. Next, the multi-class classification models Random Forest and Gradient Boosting, along with the neural networks CNN and RNN will be trained and tested using k-Fold Validation. The model with the highest accuracy from the test would be considered the best. Previous studies have shown that CNN will have the highest accuracy. The results of this project can help call centers perform behaviour assessment, and improve human-computer interactions.

Amity High School

Teacher: Catherine Piscitelli

Project # 49

Price, Allison

Determining the Risk of Future Forest Fires Due to Fuel Flammability

Completed Project, Environmental

To be able to understand the risks of forest fires in the future in order to protect the environment. This will also help save many natural sites and wildlife all over. The way that I will conduct my research is by first, collecting data from my different criteria. I used Palmer Hydrological Drought Index Data for August-September 2021 from the National Oceanic and Atmospheric Administration's (NOAA) North American Drought Monitor (NADM). I also used mean temperature and precipitation from the United States Department of Agriculture, and major roads from Natural Earth. Using QGIS Software, I am able to overlap and analyze all five base layers (fifth being the outline of the United States from Natural Earth.) By gathering this data, I will be able to not only understand which regions of the US are at the greatest risk, but also visualize the vulnerability and predict which regions suffered the most fires in that time period. I then compare my results to an updated map of the fires that had occurred during that time period. I had expected that Colorado, Southwest California, New Jersey, and the Midwestern Plains were the most vulnerable. However, Colorado suffered less fires than other regions due to higher elevation. This research is beneficial for advancing reliability of GIS technologies and enhancing forest fire research. Fire research is valuable in the sense that it has the ability to save countless lives, money, and natural sites

Ridgefield High School

Teacher: Aine Kapell

Project # 50

Rathjens, Anton

Utilizing simulation to determine the most energy-efficient structure and phase of doped 2DT-form TiO₂ for splitting Hydrogen Peroxide into Hydroxide

Research Proposal, Physical Science

TiO₂ (Titanium Dioxide) is a photocatalyst that can react with pollutants from air and water to form value-added chemicals. There is a reaction that it undergoes with CH₄ (methane) to create CH₂O (formaldehyde). In the process, H₂O₂ (hydrogen peroxide) is broken into 2HO (hydroxide). The objective of this project is to find which phase, rutile or anatase, of a 2DT (2-dimensional TiO₂) structure is the most energy-efficient in breaking H₂O₂ bonds. The project will utilize a simulation software (Avogadro) to create the structures, and use a VASP software to calculate energy. In the simulation, the phases will each be optimized and doped (coated) with other elements to find the most efficient form of each phase. Then, they will be compared, and the one with the lower ΔE (change in energy) will be counted as the more efficient one. Anatase is most likely to be the more efficient phase, because of its effectiveness in other applications. Implications of this project include more understanding of TiO₂'s reactivity with CH₄, which could be helpful in extrapolating its usefulness in CO₂-based reactions. This could then lead to a decrease in pollution if TiO₂ is able to be utilized to its full potential.

Amity High School

Teacher: Catherine Piscitelli

Project # 51

Riebling, Riley

The Probability of a Shark Attack Across the East Coast

Completed Project, Environmental

This study focuses on where a shark attack is most likely on the east coast. To begin conducting the study, all the states on the east coast of the US that have coastline were sorted in order from North to South. Then the number of usable “beach days” in each state was estimated; the amount of coastline in miles per state was also found. Using the shark tracking resource, Ocearch, the number of shark pings identified off the coast of each state was recorded. Similarly, the number of shark attacks ever reported off waters in each state was recorded using the International Shark Attack File. To make the results comparable, all data found was converted into the units of the number of attacks per number of pings, the number of attacks per number of beach days, and the number of attacks per number of beach-coastline. The new units were compared and the results showed that the states that had more usable “beach days” and had more miles of coastline were more likely to have a shark attack occur in the waters off their coast. This is important information to know because, on the larger scale of things, the human population makes a very large impact on the environment. It is essential to know where people are most likely to interact and maybe even harm animals, in this case, sharks, so people know what precautions to take so they do not harm the environment.

Ridgefield High School

Teacher: Aine Kapell

Project # 52

Rodriguez, Evia

Short-term pilot biodegradation analysis of poly (?-pinene methacrylate), poly (myrtenyl methacrylate), and poly (methyl methacrylate) synthesized in supercritical carbon dioxide.

Completed Project, Environmental

People use plastics every day, therefore; environmentally friendly biodegradable substitutes for conventional plastics including poly (methyl methacrylate) are needed. Because of this, investigating and comparing the short-term biodegradation of the renewable plastics poly (?-pinene methacrylate) and poly (myrtenyl methacrylate) to that of the non-renewable conventional plastic poly (methyl methacrylate) will aid in deciding if either renewable polymer has potential for short-term, single-use, or long-term applications. A pilot biodegradation analysis was performed on the plastics poly (?-pinene methacrylate), poly (myrtenyl methacrylate), and poly (methyl methacrylate). Samples of these plastics underwent biodegradation for 10 weeks in closed environments containing water and soil. 0.5N KOH solutions absorbed carbon that evolved from each plastic via microbial activity. The resulting solutions were then titrated with HCl to determine the amount of carbon present in each KOH solution. Interestingly, less carbon evolved from the poly (myrtenyl methacrylate) samples than from the control sample that contained only soil, indicating poly (myrtenyl methacrylate) did not biodegrade during the 10-week period. However, poly (?-pinene methacrylate) and poly (methyl methacrylate) samples evolved similar amounts of carbon, indicating these plastics have similar short-term biodegradation rates. As the plastics poly (?-pinene methacrylate) and poly (myrtenyl methacrylate) are possible renewable alternatives for poly (methyl methacrylate), this pilot biodegradation analysis illustrated that poly (?-pinene methacrylate) is more readily biodegradable and thus will have a lesser impact during the end-of-life stage than poly (myrtenyl methacrylate) and poly (methyl methacrylate).

Ridgefield High School

Teacher: Ryan Gleason

Project # 53

Russell, John

Biocement Bricks for Negative Emissions: Electrochemical Ocean Carbon Capture

Completed Project, Environmental

Atmospheric concentrations of carbon have increased by more than 10% in the past two decades, contributing to the warming effect, which has made 2020 the warmest year on record. Along with reducing anthropogenic emissions, negative emissions technologies must be implemented in order to mitigate existing carbon. The ocean is the world's biggest carbon sink, having concentrations 120 times higher than the atmosphere. Additionally, ocean acidification caused by carbon dioxide reacting with water endangers the organisms that produce the majority of the world's oxygen. Here, we designed a flow cell for the removal of carbon from the ocean. We flow in ocean water and separate it into two streams, one acidified and one basified, through the use of bipolar membrane electro dialysis, transferring ions from solutions using ion exchange membranes. This model is thermodynamically efficient, leveraging pH and temperature relationships to turn harmful dissolved inorganic carbon into something beneficial: biocement bricks made of insoluble compounds, such as CaCO_3 . By using a redox couple, such as ferricyanide and ferrocyanide, the cell runs with minimal inputs and minimal voltage losses. Costs and corrosion can be additionally minimized by the use of protective thin-film materials such as TiO_2 . Machine learning analysis allowed us to rapidly analyze material candidates and their best preparation methods, an additional precaution to ensuring flow cell stability and efficient operation. This project provides both an opportunity for companies that cannot abandon fossil fuels to be carbon-neutral, and an opportunity for the world to become carbon-negative and reduce the damages already done.

King School

Teacher: Victoria Schulman

Project # 54

Sandmeier, Yuriy

The essential 23S rRNA methyltransferase rv3579c confers intrinsic macrolide resistance in *Mycobacterium tuberculosis*

Completed Project, Health & Medical

According to the Centers for Disease Control and Prevention (CDC), in 2018, roughly 1.7 billion people were infected with *Mycobacterium tuberculosis* (Mtb). To treat tuberculosis (TB) infections, there has been a long-standing interest in using macrolides, a family of drugs that include clarithromycin and azithromycin (Z-pack), due to the fact that they are exceedingly safe and well-tolerated by most individuals. However, Mtb has intrinsic resistance to macrolides, generally rendering macrolide drugs ineffective at treating TB infections. The mechanistic basis for this resistance is only partially understood; thus, we aimed to determine whether there were additional factors responsible for this phenotype. A CRISPR interference (CRISPRi) screen performed in our lab identified rv3579c, a predicted 23S rRNA methyltransferase, to be a novel macrolide-resistance factor in Mtb. Using homology-based methods, we ascertained that rv3579c was closely related to the rlmB family of methyltransferases found in *E. coli*. We then demonstrated the essentiality of rv3579c in *M. smegmatis* (a surrogate of Mtb) and later showed that, with genetic knockdown of rv3579c, Mtb becomes more susceptible to clarithromycin, thereby highlighting a mechanism that will most likely facilitate successful treatment and elimination of TB in affected individuals. With these pivotal findings, we have laid the groundwork for further research to determine whether or not rv3579c can be targeted by chemical compounds to both inhibit Mtb growth and render the bacteria sensitive to macrolides. In the future, we aspire to use our findings to prevent the deaths and hospitalizations of countless millions of people.

King School

Teacher: Victoria Schulman

Project # 55

Sasse, Alexa

Characteristics of Regenerated Cellulose Fibers and Their Impact on the Environment

Completed Project, Environmental

Regenerated cellulose fibers such as lyocell, viscose, and many more have become popular choices in the clothing industry. The man-made fibers are made from natural materials and undergo various processes to result in a product similar to cotton, but biodegradable. Certain methods used to create fibers impose different environmental impacts. In some cases, harmful chemicals are released as by-products and many fossil fuels are used. To find the most sustainable and environmentally friendly regenerated fibers a meta-analysis must be completed that highlights the strengths and weaknesses of all the different fibers. A table was created in order to compare quantitative data such as rates of acidification, impact on global warming, water use, energy use, etc. A separate collection of data occurred that compared qualitative data such as the chemical by-product released, the process used, solvent, and etc. Overall, the goal is to look for consistent positive patterns that are backed up by affordable cost and acceptable quality. Based on previous research, lyocell is hypothesized to be the most eco-friendly fiber because it has a recyclable solvent, shows the lowest numbers in the quantitative chart, and uses a dry jet-wet spinning method when being reconstructed. It is also predicted that many of the plant-based fibers such as viscose and rayon will be eco-friendly fibers but lack in other areas because the processes use more energy and water. To name one example, the fiber process also releases a chemical byproduct, Na_2SO_4 , which when introduced to an unfamiliar flora and fauna can be damaging. With the knowledge of which regenerated cellulose fibers are the most eco-friendly, consumers will be able to purchase clothes that can reduce their environmental footprint. It also brings to light the harmful effects that the textile industry has on the environment and ways society can lessen the damage inflicted. Overall, it's important to know the product you buying and what kind of quality it's offering.

Ridgefield High School

Teacher: Patrick Hughes

Project # 56

Satheeshkumar, Sibi

Identification of druggable sites and lead compounds to target the novel ORF8 in SARS-CoV-2

Completed Project, Health & Medical

Current therapeutic strategies against SARS-CoV-2 are mainly focused on the traditional drug targets like spike proteins and viral enzymes. Other viral proteins with important roles in COVID-19 pathogenicity are not being targeted for drug discovery. For example, recent studies show that ORF8 protein may be responsible for the rapid spreading of SARS-CoV-2, compared to other coronaviruses. However, the knowledge of lead compounds and drug-docking sites for ORF8 is limited. The current study used the X-ray crystal structure of ORF8 to analyze potential drug-docking sites using DeepSite. A docking site composed of TYR58, TYR73, ILE74, ASP75, TYR79, PRO93, LYS94, and LEU95 was defined. Structure-based virtual screening was conducted against this site, using all FDA-approved small molecule compounds. "DockThor" by GMMSB and "Cheminformatic Tools and Databases for Pharmacology" by Université Côte d'Azur open-source servers for virtual screening was used. The complementarity of each small molecule compound from the database was measured against the defined binding site. The virtual screening yielded a number of promising lead compounds including Paliperidone (Score: -119.990) and Glycerol phenylbutyrate (Score: -114.720). Top-ranked compounds can undergo further biochemical studies or lead compounds for drug repurposing against SARS-CoV-2. For the first time, this study provides potential lead compounds targeting ORF8 protein.

Darien High School

Teacher: Guy Pratt

Project # 57

Saunders, Tyler

Data mining on the effect of LmrS on antibiotics's MIC.

Completed Project, Health & Medical

S.aureus is a pathogenic bacteria that has become resistant to many antibiotics used to treat it and has become a major problem. One of the problematic types of S.aureus is methicillin-resistant S.aureus or MRSA. This superbug has become a massive problem because it has become resistant to methicillin, one of the most common antibiotics used to cure these types of infections. On MRSA there are efflux pumps which are physical protein pumps on bacteria that can pump out toxins and antibiotics. One of the efflux pumps called LmrS gives MRSA resistance to many antibiotics, including some of the last ones used in treating MRSA. Because of this, the project is going to be on figuring out through bioinformatics, which is the study of biology and data, how effective LmrS is at pumping out those antibiotics. Because LmrS has been recently discovered, more research has to be done to more clearly understand its role in MRSA and MRSA's antibiotic resistance. The project will take sources from many different studies and articles and will average the results to acquire more accurate data on how impactful LmrS is in increasing antibiotic resistance in this pathogen. This will clear up how scientists see LmrS and MRSA and will lead to further understanding of MRSA and LmrS. The project is not included in using any pathogenic bacteria or dangerous materials but is doing data mining to understand the impact of LmrS on MRSA.

Newtown High School

Teacher: Timothy DeJulio

Project # 58

Simari, Charlotte

Positive Reinforcement of Invasive Species Populations Through Manipulation of Microclimate by *Berberis thunbergii*, *Amyntas agrestis*, and *Lumbricus terrestris*

Completed Project, Environmental

Positive Reinforcement of Invasive Species Populations Through Manipulation of Microclimate by *Berberis thunbergii*, *Amyntas agrestis*, and *Lumbricus terrestris* Invasive species have been taking over areas of ecosystems that would be the habitat to native species and are making it more difficult for native species to remain in the area. The invasion of species is often driven by outside forces and other organisms, even sometimes other invasive species. Here we show that *Berberis thunbergii*, *Amyntas agrestis* and *Lumbricus terrestris* all positively reinforce each other by manipulating the microclimate of the soil by adjusting pH levels, microfauna levels, and macrofauna levels. To measure earthworm populations, seven logs were flipped over at two sites: one containing Japanese Barberry and one not. To measure invasive plant species, photos were taken of the sites. By analyzing earthworm counts in sites with and without Japanese Barberry, there is a correlation between greater earthworm presence and Japanese Barberry. The photos were analyzed by counting amounts of native and invasive species, and by analyzing the photos there is a correlation between Japanese Barberry and greater presence other invasive plant species. The data was proven to be significant by using a chi-square analysis. The invasion plant species that were found at the sites were suited better to higher pH as are earthworms, and Japanese Barberry has been known to raise soil pH, therefore a new method of mitigating invasive species could be treating the soil to decrease the pH and drive out the invasive species.

Darien High School

Teacher: Guy Pratt

Project # 59

Staubly, Sam

Accessible program and system to accurately align a star tracking mount using a camera.

Completed Project, Physical Science

To get great photographs of the night sky, a lot of accuracy is required. Star tracking mounts are used to track the stars as they move across the night sky, so the camera can gather a lot of light. To use a star tracking mount, it must first be aligned with an invisible point in the sky. This is often done with expensive equipment, but can feasibly be done with a telephoto camera and a custom program. How can we create a program to both align the mount, and verify the accuracy of the alignment, so the resulting images are acceptable? First, a program will be written to precisely calculate the location of the North Celestial Pole in relation to nearby stars. Another program will be written to guide the user through aligning the star tracking mount to the North Celestial Pole using the telephoto camera. Then, the alignment accuracy will be verified through the program. The objective is to polar align the setup in around five minutes with an accuracy of 30 arc seconds. The setup should also be portable, ideally using a phone app for alignment. The algorithms should be accurate and reliable, with quantitative data displaying the accuracy of the alignment. Pending the successful completion of this project, amateur astronomers will benefit from improved alignments as well as a lower entry price into astronomy. With more people able to capture better images of the sky, more people will be inspired to pursue astronomy in the future.

Newtown High School

Teacher: Timothy DeJulio

Project # 60

Sweeney, Edwin

Creating a Database to Visualize Variables Related to Depression in Child and Adolescent Health

Completed Project, Behavioral

Depression in adolescence is a prevalent issue in mental health research. It affects the physical and mental state of teens negatively and symptoms can be fatal. Researchers are always working to understand the factors leading to depression in teens. The National Survey for Drug Use and Health (NSDUH) collects data on mental health and other social factors prevalent in the adolescent population. Considering the data is open source, no tool exists for this data in the interest of interpreting and visualizing different factors related to depression in the child and adolescent population. The purpose of this project was to create a tool to centralize and visualize the causes and effects of depression in children and adolescence. Constraints include time, the consistency of the data in the dataset, and the hardware being used to process the data. The solution was to build a database to migrate select data into and create the visualization tool using power bi. A database was created using a relational database called Microsoft SQL Server. Various data factors were imported from select NSDUH databases and tables were designed to house the data. The SQL server was linked to power bi, where the data was visualized. So far, the data is able to be queried from the dataset, and the visualization tool is successfully able to communicate with the database. Creating a tool to visualize factors relating to child and adolescent depression from the NSDUH will allow researchers to better compare the causes and effects of depression.

Amity High School

Teacher: Catherine Piscitelli

Project # 61

Tang, Luhai

The Influence of Perceived Parenting and Extracurricular Participation on Creativity Among High School Students

Completed Project, Behavioral

Fostered in many ways, multiple studies have shown that creativity can be nurtured in a more open and supportive environment. Alternatively, creativity can be diminished in a more constrained and unsupportive environment. The influence of extracurricular activities on creativity depend on many factors. They can be detrimental or beneficial depending on the the type of activity and the parental attitude towards it. The purpose of this project was to examine the association between perceived parenting, extracurricular activities, and creativity among high school students. There were three hypotheses. First, it was hypothesized that perceived parental support of autonomy is positively associated with creativity. Secondly, perceived parental overcontrol is negatively associated with creativity. Thirdly, participation in extracurricular activities is positively associated with creativity. The independent variables were parenting styles and participation of extracurricular activities, and the dependent variable was creativity measured through the consensual analysis technique. Following a consent form, participants were given questionnaires, which included (1) Parenting Style Measure (Lau & Yuen, 2013), (2) an extracurricular activity questionnaire (Liang et al., 2021), (3) a self reporting creativity questionnaire (Runco Ideational Behavior Scale, Runco & Basadur, 1993), and (4) an objective measure of creativity (Product oriented measure through the Consensual Assessment Technique, Amabile, 1996; Niu & Sternberg, 2001). Pearson correlation was used to examine the three major hypotheses of the study. Moreover, a hierarchical multiple regression analysis was used to examine relative contribution of parenting styles and extracurricular activities to creativity. The data thus far supports the three hypotheses.

Amity High School

Teacher: Catherine Piscitelli

Project # 62

White, Anna

The Effect of Placebos and Nocebos on Pain Perception

Completed Project, Behavioral

The placebo effect is a relatively well-known concept, but few people are familiar with the nocebo effect. The placebo effect refers to a supplement or treatment plan that has no effect on a person's body but gives the impression that something is improving, in this case pain being relieved, due to the anticipation or expectation. The nocebo effect, on the other hand, is based on a person's negative expectations or prior information about their treatment, causing the treatment to have a worse overall outcome than it would otherwise. This is related to pain and how people tend to exaggerate the severity of their pain merely due to negative implications/reactions. This project will consist of figuring out how the placebo and nocebo effects affect the perception of pain through the use of neurological and psychological processes, and drawing suitable conclusions through the data being used. What will be done is analyzing data from several studies and developing conclusions based on what other researchers have discovered. How this will be executed is through interviewing doctors and researchers about their studies and comparing data, as well as doing my own research, to come to a clear conclusion regarding how significant placebo and nocebo effects are when it comes to a pain relief treatment.

Newtown High School

Teacher: Timothy DeJulio

Project # 63

Wijesekera, Aadya

Modifying an Application to Help Oral Immunotherap Users Track Their Symptoms, Incidence of Allergic Reactions, and Progress

Completed Project, Health & Medical

Food allergies are on the rise around the world, posing life-threatening consequences with the only treatments being allergen avoidance and emergency administration of epinephrine. Oral immunotherapy or OIT provides a new alternative, where patients are introduced to increased doses of their allergen to increase tolerance. The treatment plan is very personalized, making logging patient symptoms very important. The purpose of this project is to modify the application's user interface from last year's project and make the application HIPAA compliant. The app was further developed using the Integrated Developer Environment, Xcode, to modify the user interface and make it more user-friendly and visually appealing. Figma was used to further develop the different components of the application, making them more visually appealing. Amazon Web Services was used as the database, with a Business Associate Addendum (BAA) signed to ensure that AWS would do its part to safeguard sensitive information. Phase 1 of testing was proof of concept that the app works and meets all the criteria, while Phase 2 involved human participants reviewing the app, voting whether they prefer the app or the paper diary, and giving additional feedback. In the future, this app could be used daily to help OIT patients manage their symptoms and reactions after taking a dose. It could also be used by doctors to keep more detailed logs of their patients' symptoms in order to provide better care.

Amity High School

Teacher: Catherine Piscitelli

Project # 64

Wijesekera, Soumya

Determining a Correlation Between Levels of Creativity and How People Perceive Literal Optical Illusions

Research Proposal, Behavioral

The perception of optical illusions are based on eye position and eye movement, but the effect of the viewer's level of creativity on the ability to perceive the illusions has not been significantly studied. The purpose of the research question is to determine if a correlation exists between creativity and the perception of optical illusions. It is hypothesized that if a "very creative" person analyzes a variety of literal optical illusions (double image illusions), then they will be more successful in seeing all images presented than a "creative" person, because the two categorized people have different ways of thinking. Participants will first take a creativity test form that will be scored upon fluency, originality, flexibility and elaboration. Once all responses are submitted, each participant will be labeled as a "creative" or a "very creative" person. The sum total score of the responses will divide the subjects into either a "creative" group or "very creative" group, based on the halfway point. The second section of the form will present participants with literal optical illusions, and then question what they saw in those illusions. Each participant's response to the double image illusions will be analyzed to see if there was any correlation between their creativity levels. The description of the image participants perceived as well as how many correct images they perceived will be taken into account when analyzing the form results.

Amity High School

Teacher: Nicholas Shamp

Project # 65

Xu, Alice

Determining the Effect of Climate Change on the Distribution and Habitat Availability of the Sachatamia punctulata

Completed Project, Environmental

Climate change significantly affects the distribution, behavior, and biodiversity of various species. Amphibians, who have weak dispersal abilities, are highly sensitive to environmental changes. The Sachatamia punctulata, a species of glass frog, is one of these species. The purpose of this project is to determine how climate change will affect the distribution and habitat availability of Sachatamia punctulata in the future in comparison to present day. I hypothesized the distribution and habitat availability of the Sachatamia punctulata would decrease under future climate change conditions. The IV is present and projected future climate conditions for the years 2050 and 2070. The DV is the amount of predicted suitable habitat/distribution of Sachatamia punctulata. The control is current habitat distribution data. After reviewing studies conducted on the Sachatamia punctulata, variables affecting distribution were determined. Distribution data and geographic range of the species were gathered from GBIF. Data was inputted into the ecological niche modelling program MaxEnt, along with current, 2050, and 2070 climate conditions in two different socio-economic pathways. After applying the modelling algorithms, model accuracies were validated. Landscape graphs were analyzed indicating possible future habitat locations, and percentages of available habitats were compared within a 50%, 75%, and 95% threshold of habitat suitability. Time period data was compared to analyze how future conditions compare with present ones. Results thus far support the hypothesis. Results could give insight as to how amphibians will fare in the future as a result of the changing climate.

Amity High School

Teacher: Catherine Piscitelli

Project # 66

Xu, Sophie

To shine or not to shine – how does a zebrafish pigment cell decide to turn black or silver?

Completed Project, Health & Medical

What are the regulatory elements important for regulating iridophore gene expression? I have used bioinformatics to analyze functional epigenomic data with the goal of identifying regulatory elements essential for zebrafish pigment cell fate determination. One of the most important problems in biology is how the same genetic material all cells share gives rise to different cell types in development in a multi-cellular organism such as humans. The information orchestrating how each cell expresses different genes is encoded on top of the genetic information, thus is defined as “epigenetics”. How epigenetics determine cell fate thus holds the secret to the most fundamental question in life. Zebrafish pigment cell differentiation provides an attractive model to study cell fate progression. Here, a single neural crest progenitor engenders two morphologically distinct pigment types: black melanocytes and shiny iridophores. How the epigenetic factors contribute to pigment cell fate is poorly understood. Previously Wanglab from WashU mapped the epigenetic profiles of melanocytes and iridophores, including DNA methylation, chromatin accessibility, and gene expression. I have used bioinformatics approaches to process and analyze these next-gen sequencing based large epigenomic datasets. I compared the epigenome and transcriptome landscape between melanocytes and iridophores, revealed differentially expressed genes and differentially epigenetically modified regions, and predicted regulatory elements important for iridophore gene expression. In the future, I plan to experimentally validate the most interesting candidate regulatory elements.

Darien High School

Teacher: Christine Leventhal

Project # 67

Yang, Henry

Developing a Graphical User Interface to Organize E-Commerce Product Attributes

Completed Project, Physical Science

Throughout the year, retailers offer various discounts, “deals,” to entice customers. As deals have become a new norm in commerce, searching for the best deals has become more tedious. Existing forum communities share deals among large audiences but rely on community input to find and rank them. Previously, my project successfully utilized the eBay API to develop a backend Python program to extract product attributes, characteristics about commodities. In continuation, the purpose of this project was to create a graphical user interface (GUI) to organize and display such product attributes. By periodically running the backend program, product attributes were stored in databases. A GUI was created using an open-source Python GUI Builder, PyGuBU. This GUI displayed the various product attributes pulled from the API or retrieved from the databases. Using existing Python libraries, features for plotting historical pricing data over time and responding to user input were integrated. Reiterations occurred throughout the project timeframe to improve features and resolve issues. Results thus far indicated success in the GUI displaying retrieved information. Furthermore, historical pricing data was successfully plotted over time. However, no conclusions were drawn regarding databases thus far. Effectiveness was measured using qualitative measurements: determining whether specific criteria, such as user input or plotting data, were met. However, as real-time data was unavailable for this specific API, simulated products and price variations were used. The main implication was to provide deals to greater audiences without the hassle of searching for them and potentially saving the average consumer money.

Amity High School

Teacher: Catherine Piscitelli

Project # 68

Yin, Tiffany

Computer Light Inhibits Caenorhabditis Elegans Development

Completed Project, Health & Medical

In a rising technological world, people use electronic devices on a daily basis and are constantly exposed to blue light emissions from the devices. Computers are one of the most commonly used electronic devices, and the high intensity blue light emissions from computer screens may have a negative effect on human development. C.elegans are microscopic nematodes that have a similar genome to humans and are popular subjects for scientific research. This experiment examines the difference in size between C.elegans exposed to computer light during the developmental stage and C.elegans remaining in the dark in the same stage. Subjects were placed in an incubator for 48 hours to be exposed (or unexposed) to computer light, before being taken out to be imaged. The image of 10 randomly selected C.elegans from each group was taken with a Keyence BZ-X800 microscope. After using the ImageJ software to measure average lengths of C.elegans in the two groups, it has been found that computer light exposure during the developmental stage causes a growth stunt in C.elegans. These results are concerning because a similar developmental restriction could be occurring in humans as well.

Ridgefield High School

Teacher: Ryan Gleason

Project # 69

Zhan, Annie

Optimizing the Design of an Absorption-Capable Hydrocolloid Wound Dressing to Inhibit Bacterial Infection Using Silver Nanoparticles

Completed Project, Health & Medical

The optimal wound dressing should include moisture retention, adequate durability, and antimicrobial properties, which all promote an ideal healing environment for a wound. Scientists have researched different ways to incorporate these factors into wound dressings using different materials and components. Nanocrystalline silver has been pointed out as an effective material in wound dressings, as it works as an antiseptic against bacteria. This project focused on using nanocrystalline silver to incorporate antimicrobial properties into a hydrocolloid bandage. In my past research, I was able to successfully create a hydrocolloid bandage that could absorb wound exudate, as normal hydrocolloids are limited in the amount of drainage they can hold. However, it was unknown whether the bandage possessed the antimicrobial properties of an ideal wound dressing. Therefore, utilizing the same procedure from my past project to create the bandage, I added nanocrystalline silver gel with the prospect of incorporating antimicrobial properties in it. After creating the bandage, I conducted a Kirby Bauer disc diffusion susceptibility test, testing the bandage against a common skin microbe, Escherichia Coli. Zones of inhibition were measured to determine effectiveness. To ensure safety, this was done in a laboratory setting with proper safety, equipment, and assistance from my mentors. The objective was for the bandage to inhibit a significant amount of bacterial growth. Progression of this project is on track to complete goals as set forth. If successfully done so, this bandage can possibly be used as a primary wound dressing for future surgical applications.

Amity High School

Teacher: Catherine Piscitelli

Project # 70

Ahmed, Aiden

Using Thermoelectric Generators to Supplement the Power generation of Solar Panels

Research Proposal, Physical Science

Various fuels, like fossil fuels, are not in an endless supply and renewable energy sources need to be utilized. Solar panels lose efficiency as they get hot, so more efficiency from solar panels is desired. Solar energy is a popular source of renewable energy. As more applications are powered by solar power, the loss in efficiency means more lost potential power. The criteria for this project was that the combined power generated by the solar panes and TEGs must be able to generate a statistically significant increase in power generation. The constraints are that it must be built and tested within 3 months, the cost of materials, and testing conditions will not be constant (changes in weather). 10 thermoelectric generators(TEGs) attached to a 25-watt solar panel using thermal paste. The TEGs connected in parallel to a set of output terminals. Two solar panels placed outside for eight hours. One of the solar panels had 10 TEGs. Visibility, temperature, and weather were recorded at the beginning of each day of testing. Testing outside was preferred since it allowed the tests to be more realistic. This was repeated over 3 months. A multimeter was used to monitor voltage and current. Statistical analysis was used to determine if TEGs created a statistically significant increase in power generation to a lone solar panel. This device will encourage further research into improving the efficiency of solar panels, energy generation, and also show potential improvements to the efficiency of large-scale solar panel arrays.

Amity High School

Teacher: Catherine Piscitelli

Project # 71

Akbar, Faryal

Analyzing the effects of an acid based diet on the composition of murine teeth

Research Proposal, Health & Medical

Acid has the ability to dissolve bones, including teeth, and there is currently no complete understanding of how a continuous acid in the buccal cavity, simply put as the mouth area, affects the composition of teeth. Calcium hydroxyapatite which is found in teeth is a mineral composed of calcium and phosphate. The mineral is broken down when acid is added, resulting in a change in composition. However, the specific results of these reactions have not been identified. The goal of this study is to see how acidic diets affect the composition of teeth in murine, or mice. The procedure will involve extracting teeth from murine that have previously been exposed to acidic diets. The murine have already been exposed to acid based diets and are deceased. The teeth will be collected from both acidic and non-acidic diet-fed murine. Following that, Raman spectroscopy that I will personally perform will be used to conduct a chemical analysis. Using the results of the spectroscopy, a fitting procedure will be performed on the peaks, leading to a mathematical analysis to determine the mineral type and mineral content. Statistical analysis will then be performed which I will also be personally conducting. I expect to find the composition change, specifically a decrease in calcium hydroxyapatite. The findings of this study can help dieticians deal with food and diet, as well as understand how acid can help cavities.

Amity High School

Teacher: Catherine Piscitelli

Project # 72

Angel Tenorio, Fernando

Opioid Epidemic Before and After the Introduction of Synthetic Opioids in Connecticut

Research Proposal, Health & Medical

The ongoing opioid epidemic has led to hospitalizations and deaths. Since 2012, there has been a rise in the number of US deaths due to opioid-related drugs, specifically deaths related to overdose from synthetic opioids like fentanyl. In Connecticut, there has been an increase in opioid overdoses and deaths related to opioid abuse since 1997 (Green, Grau, Carver, Kinzly, & Heimer, 2010.) To evaluate the impact of increased usage of synthetic opioids in the state of Connecticut, an observational study will compare new data collected from 2012 to 2020 by the Connecticut Department of Public Health to previously published opioid abuse outcomes. Regression analyses will be performed to evaluate the impact of increased fentanyl use and other synthetic opioids. Outcomes measured will include deaths and hospitalization. It is likely the increased use of fentanyl and other synthetic opioids in CT since 2012 is correlated to increased poor outcomes. This evidence would support health policymakers to create legislation to relieve the financial, social, and cultural repercussions of the use of synthetic opioids. Evidence that leads to better systems might have a positive impact on the quality of life of all communities affected by this opioid crisis.

Staples High School

Teacher: Amy Parent

Project # 73

Barczak, Alyson

Study of Parents Trustability of Social Robots Targeted to Children

Research Proposal, Behavioral

Robots are becoming prevalent in society, in homes, companions for children, and forming physical relationships. Social robots are becoming more frequently targeted to children. Research shows the human brain possesses an ontological category catered to artificial-looking robots, but not ones appearing "somewhat human." The trustability of various robotic architectures requires further research, specifically the impacts of physical appearance on the perception of trustability, namely in parents. For the purpose of this research, trust will be defined as outlined in the article, Trust in Robots: Challenges and Opportunities as "... a belief, an attitude, an affective response, a sense of willingness, a form of mutual understanding, and as an act of reliance." A sample of ~20 parent participants of children ages 5-10 (target age range of various social robots currently on the market) will be shown videos of different social robots performing various tasks, moving around, and speaking. Videos of interactions with children will not be shown to avoid possible bias. Participants will complete a survey ranking the robots on a scale from untrustable to trustable on the premise of letting them interact with their children. The expected results are that robotic agents appearing "robot-like" will be perceived as more trustable by the parents than ones appearing human-like. Implications of this research will lead to a higher understanding of the effects of different facades and architectures on the perception and trustability of children-targeted social robots.

Ridgefield High School

Teacher: Patrick Hughes

Project # 74

Belluscio, Emma

Adjuvant Capecitabine With BRCA1 or BRCA2 Breast Cancer Mutations

Research Proposal, Health & Medical

New medicines are needed to prevent recurrence in patients with early breast cancer caused by a BRCA1 or BRCA2 hereditary mutation. Adjuvant cancer medications such as Capecitabine will be beneficial to breast cancer patients who have remaining BRCA1 or BRCA2 germline pathogenic breast cancer or likely pathogenic variants following neoadjuvant chemotherapy and surgery. Capecitabine, a chemotherapy drug, will be used to combat these remaining breast cancers, ultimately increasing the life expectancy of the person carrying the BRCA1 and BRCA2 mutations. Patients' initial treatment will continue alongside either capecitabine or a placebo. The placebo's purpose is to get clear and concise data of Capecitabine. Through the process of randomization in this double blind trial patients will either be assigned to 1 year of oral Capecitabine or placebo. It is predicted that during this 3-year invasive disease-free treatment, among patients with germline BRCA1 or BRCA2 pathogenic or likely pathogenic variants, adjuvant Capecitabine will be associated with significantly longer survival free of invasive or distant disease than the placebo group.

Darien High School

Teacher: David Lewis

Project # 75

Berardi, Leo

When sound is played for different times, volumes and pitches, it was determined that plant growth significantly increased (up to 2cm) when a high pitch was projected.

Research Proposal, Environmental

There are several scientific studies that confirm that music benefits the growth of a plant, but none specifically contrast length of time, volume and pitch. For a human, when you turn on the radio, sound waves in the medium create vibrations, which causes the eardrum to vibrate. Similarly, with plants, this same phenomenon happens because they receive these sound waves through their protoplasm and are predicted to help increase the proficiency of their growth. In order to compare the three variables we set up a designated Quiet Area and a Sound Area in which we tested the effect of sound on their height and number of leaves. We carried out each test in the Sound Area using a homemade soundproof box (made with materials that proven to repel sound), and after the designated times we transferred them to the Quiet Area. Test 1 compared different lengths of time a sound was played (0,1,4,8 hours), test 2 compared the volume (10dB&80dB), and test 3 compared different pitches, ranging from 5-1000Hz*. The pitch experiment proved to obtain the highest growing plants (10.4), while the control group in the volume experiment did statistically better than the other variables in plant height. These results imply that volume does not affect plant growth, while pitch does. *variables not tested were held constant

King School

Teacher: Victoria Schulman

Project # 76

Berkery, Isabelle

Determining the Association Between Commercial Fishing Presence and Mako Shark Locations using GPS Tracking Data

Research Proposal, Behavioral

Data collected in the past 20 years shows that the population of Mako Sharks is quickly dropping due to a major overfishing problem, which fishery managers have failed to act on. My research question is what is the association between areas with a higher presence of long-line fishing boats and mako shark populations? It is hypothesized that areas with a higher presence of long-line fishing boats are associated with a lower mako shark population because of the by-catch and habitat damage this kind of fishing causes. I will use data from the Global Fishing Watch Map and other online databases. Using this data I will find coordinates of areas that are heavily fished. Then I will analyze data collected from location trackers on mako sharks and find coordinates of areas where mako sharks are more commonly found. I will then create a linear regression model to determine whether there is an association between fishing boats and mako shark presence. I expect to find a negative correlation between heavily long-lined fished areas and the mako shark population. I expect that a heavily fished area will have a lower population of mako sharks due to the constant by-catch of mako sharks, in addition, areas that are not a long-line fishing hotspot are predicted to have a larger mako shark population. My research would help locate areas where mako sharks are in the most danger and provide the evidence necessary to establish conservation zones.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 77

Bernal, Martina

The Role of Bilingualism in Enhancing Adolescents' Ability to Suppress Grammatical Illusions

Research Proposal, Behavioral

The bilingual advantage theory claims that the practice in switching between two known languages that occurs in the brain for each specific context improves cognitive functions; specifically executive functions. My study focuses on a specific branch of executive function: the cognitive parser, particularly how it varies in strength in monolinguals and bilinguals. The purpose of this study is to identify the relationship between bilingualism and the cognitive parser using grammatical illusions (sentences that manipulate the cognitive parser into treating it as well-formed while it is not). The novelty of this study comes from the testing of adolescent participants rather than children or adults. My methods will require 10 participants: five Spanish-speaking bilinguals and five monolinguals ranging from 14-17 years old. They will be given a timed task featuring 10 grammatical illusions and normal sentences which they will judge as ill formed or well formed. My expected results will show that bilinguals outperform monolinguals in detecting illusions, but will be slower in judging the stimuli, illusory or not. These results additionally show that bilinguals have, accordingly, an enhanced ability to attend selectively to various aspects of the linguistic stimuli.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 78

Bhattacharya, Aalok

Effect of skull stripping and segmentation preprocessing along with wavelet transform feature extraction on GoogLeNet convolutional neural network on classification accuracy of Alzheimer's Disease and Mild Cognitive Impairment

Research Proposal, Health & Medical

Detection of Alzheimer's Disease (AD) as early as possible, such as its precursor Mild Cognitive Impairment (MCI), is aided by computer analysis of magnetic resonance imaging (MRI) of the brain. Computer systems screenings patients for different stages of AD can classify large amounts of MRI brain volumetry changes. Convolutional neural networks (CNN), a deep learning technique, have proven effective at taking MRI inputs, denoising, and classifying scans. However, the accuracy of classifications (AD vs MCI vs cognitively normal) can be inhibited by their limited scope of preprocessing and the unstandardized format of MRI scans. In this proposal, de-identified MRI scans will be acquired from the Alzheimer's Disease Neuroimaging Initiative (ADNI). Baseline classification accuracy will be achieved by running unmodified scans through a GoogLeNet CNN. Next, the Statistical Parametric Mapping 12 (SPM12) and Computational Anatomy Toolbox 12 (CAT12) MATLAB programs will be used to preprocess MRI scans through skull stripping and segmentation into sections of gray matter. The scans will then go through feature extraction via the wavelet transform to remove noise. The scans will be classified after each step and evaluated for improved accuracy vs the control. It is expected that the CNN receiving both pre-processed and wavelet feature extracted scans will have the highest accuracy. Should the pre-processing and feature extraction significantly improve classification accuracy, another efficient and accurate method for screening patients for AD and MCI will be available easily.

Staples High School

Teacher: Amy Parent

Project # 79

Bierowski, Mia

Creating a Web-Based Application That Can Aid in Identifying and Differentiating Between Different Forensically Relevant Blowfly Species

Research Proposal, Environmental

Forensic Entomology involves the application of the study of insects and other arthropods in criminal investigations. Blowflies are a species of Calliphoridae commonly found at death scenes and are used to accurately calculate PMI (postmortem interval). Digital identification keys exist, such as SmartInsects, which is an app that guides users to properly collect and preserve entomological evidence; none lead users to identify a species using a comparison of two abundant species morphology. The goal of this project is to design a digital identification system that can replace inefficient paper identification keys with an application that uses a dichotomous key that compares *Phormia Regina* and *Lucilia Coeruleiviridis*. Methods will be completed in 4 stages- data collection, app creation, and app revision. Data collection includes trapping, freezing, pinning, and identifying specimens as *Phormia Regina* or *Lucilia Coeruleiviridis* and identifying the differences in their morphology. Each specimen will be identified under a microscope by using existing keys to observe each flies morphology. While I complete all of the field work my mentor will assist in accurately identifying each fly with higher quality materials. Criteria includes collecting significant amounts of forensically relevant data for the application, the application has to be functional and lead users to the accurate species. Some constraints include time, lack of knowledge in coding, as well as climate affecting the amount of fly specimens. Implications of this project aim to decrease misidentification of insects and increase the knowledge of forensically relevant insect species.

Amity High School

Teacher: Catherine Piscitelli

Project # 80

Biolsi, George

The Effects of a Combination of Discrete Isometric and Body Weight Resistance Training on Anxiety and Stress in a group of Sedentary Adults.

Research Proposal, Health & Medical

Following nationwide SARS Cov-2 (COVID-19) quarantines, sedentary behavior has become increasingly worse due, in part, to a lack of available facilities to perform physical exercise or fear of illness. Not only does sedentary behavior lead to health issues, but trepidation associated with quarantine or the virus itself has also increased stress and anxiety rates, which are detrimental to mental health. In contrast to the effects of structured exercise on mental health in heterogeneous populations, discrete exercises (i.e., resistance or isometric exercise) are not as well studied with regard to mental health in sedentary individuals. Discrete exercise, which does not require equipment, is conducive to quarantine restraints and fears of contracting COVID-19. Therefore, the objective of this study is to determine the effects of discrete exercise on sedentary adults who self-report high levels of stress and or anxiety. Participants will perform progressive isometric upper body exercises and bodyweight lower body exercises three times per week in this single group repeated measures study. Mental health will be assessed by the Hospital Anxiety and Depression Scale (HADS) and Perceived Stress Scale (PSS). Physical performance will be evaluated by handgrip dynamometry and Timed Up and Go (TUG) tests. Analysis will include descriptive statistics and repeated measure ANOVAs with Bonferroni post hoc correction where significance ($p > 0.05$) is detected. Discrete exercise is expected to significantly lower self-reported stress and anxiety. The use of accessible exercise regimens could be adopted on a larger scale to lower the incidence of debilitating mental health issues.

Darien High School

Teacher: Guy Pratt

Project # 81

Blackman, Drew

Thiamine vs. Alcohol Related Dementia

Research Proposal, Health & Medical

Dementia is a group of damaging symptoms that affect more than 3 million American citizens every year. This condition causes memory loss or lack of judgement, however most concerning is the fact that most cases of dementia are irreversible, though they might be treatable. However, one possibly preventable strand of dementia is one caused by alcohol (ARD). Alcohol-Related Dementia is caused by an excess amount of iron from alcoholic products entering the brain, causing other harmful plaques and irons to be able to enter the brain. Therefore, there can be a way to prevent iron from entering the brain as much as possible through increasing the consumption of thiamine in order to keep the blood-brain barrier (BBB) intact. The BBB is essential in regulating the products that enter the brain like irons, which are the organisms involved in dementia. Thiamine has been proven to keep this blood-brain barrier intact. Therefore, by using MRIs we can test the brain capacity of three mice, one which is given alcohol and thiamine, one which is given only alcohol, and one which is given nothing. An MRI would be able to accurately tell the amount of iron in the brain of each mouse. The results of this experiment would help find a thiamine-based cure to ARD and also lead to possibilities of curing dementia in general.

Ridgefield High School

Teacher: Patrick Hughes

Project # 82

Brown, Kate

Determining the Structural Differences of the Cerebellum and Gray Matter Structures of MSA Patients with Similar Disease Severity and Duration

Research Proposal, Health & Medical

Multiple system atrophy (MSA) is a rare adult-onset progressive neurodegenerative disorder that affects the autonomic nervous system and movement. Multiple system atrophy can be divided into two subtypes depending on whether the prevalence of symptoms is more parkinsonian or cerebellar; these two subtypes are referred to as MSA- P and MSA- C. Multiple system atrophy causes deterioration and atrophy of portions of the brain that are needed to regulate internal body functions, digestion, and motor control. The purpose of this project is to determine the structural differences of the cerebellum and gray matter structures of patients with similar multiple system atrophy and determine whether there is a difference in cortical thickness. We hypothesized that MSA- C, and MSA- P patients with similar disease severity and duration will have structural differences in the cerebellum and deep gray matter structures and no difference in cortical thickness. This experiment aims to determine intergroup differences in cortical and subcortical structures and use gray matter and supervised machine learning algorithms to classify each patient's multiple system atrophy subtypes accurately. We will use the Support Vector Model to analyze data for classification and regression analysis of the subcortical data to determine the differentiation between the MSA phenotypes. These results will indicate that multiple system atrophy patients of different subtypes have the same cortical thickness but different structural differences in the cerebellum and gray matter structures. Results of this study will increase interest in detecting specific MRI changes to distinguish structural differences in research across the world.

Darien High School

Teacher: Christine Leventhal

Project # 83

Buckjune, James

Measuring Dune Migration in The Gale Crater Region

Research Proposal, Physical Science

The exploration of Mars is on the horizon with the growing popularity of private companies including Bigelow Aerospace, Boeing, Orbital ATK, SpaceX, and more. The logistics of exploration and search for possible life on Mars depend on dune movement. Through the recent influx and analysis of High-Resolution Science Experiment Images (HiRISE) and Context Camera (CTX) images, we know that many regions of Mars contain active dunes. Examples of these regions are Nili Patera, Herschel Crater, Hellespontus Montes, and others. Regions with active dunes indicate a higher probability for biosignatures due to the protection that is provided from the gamma rays. The Gale Crater is located close to the equatorial line. This crater has a history of water, resulting in it being a focal point for rovers in the search for biosignatures. The Gale Crater has many types of dunes, including barchan dunes that have been proven to migrate at rates of about 1.7m per 4 martian months in the Nili Patera region. If two current HiRISE images of the Gale Crater were analyzed, it would be expected that I would see clear migration of barchan dunes at a similar rate to the Nili Patera region. If these expected results are observed, it would point to a higher probability of detecting biosignatures in the Gale Crater. This information and piece of criteria for the presence of biosignatures would also confirm the consistent migration of barchan dunes in different regions of Mars.

Darien High School

Teacher: David Lewis

Project # 84

Cavallaro, Grace

Creating an Effective Natural Nail Polish Remover Alternative

Research Proposal, Physical Science

Currently, there is a need for a natural nail polish remover that is just as effective in removing nail polish as existing removers full of chemicals, such as acetone. Recent studies suggest lemon juice as a makeshift nail polish remover. Additionally, many suggest using alcohol products as removers. Both products are non-toxic, so a potential natural, effective nail polish remover could consist of citric acid, the effective ingredient in lemon juice, and isopropanol, or rubbing alcohol, in water. The ratio of citric acid to isopropanol, as well as the concentrations of those two ingredients in water will be tuned to optimize the remover performance. The control in this experiment will be a traditional acetone nail polish remover. The IV will be the type of nail polish remover used, the ratio of citric acid to isopropanol, and the concentration of effective ingredients in the water. The DV will be the amount of time it takes to remove two coats of nail polish on fake nails. The hypothesis is that if the ratio of isopropanol to citric acid is 1:1, then the nail polish remover will take the shortest amount of time to remove the nail polish, making it the most comparable to the acetone remover. This new natural nail polish remover, if effective, could perhaps be beneficial to those who wear nail polish often by giving their nails a break from the chemicals in strong removers that can cause irritation.

Amity High School

Teacher: Catherine Piscitelli

Project # 85

Chamberlin, Oliver

Photosynthetic Inhibition of Karenia Brevis by Flavonoid Barley Extracts (Hordeum Vulgare)

Research Proposal, Environmental

The algae most responsible for red tide phenomena, *Karenia Brevis*, has created a pressing issue for residents of Southern Florida's coastal waters and the Southern Florida ecosystem. This algae release of toxic brevetoxins, which accumulate in shellfish and marine species, can cause bronchoconstriction, hemolysis, immune suppression, and genetic damage (Pierce, R. H., & Henry, M. S. 2008). In humans, these toxins also cause gastroenteritis and neurological symptoms characteristic of neurotoxic shellfish poisoning. (Owen, D. P. 2019). Red tide also costs 12-36 million(Owen, D. P. 2019) dollars to the tourism and seafood industries annually. This study aims to quantitatively explore the effects of barley extract(*Hordeum Vulgare*) on the growth of the dinoflagellate *Karenia Brevis*. Both experimental and control groups will be grown in saltwater solution with L/20 medium(Ferrier, M.D., Armbruster, E.A 2002)) both under the same environmental conditions of light(12/12-hour photoperiod), humidity, and temperature, as well as solution conditions of maintained salinity, nutrient levels, and dissolved solids content. Experimental groups will be grown only with the addition of the independent variable of *Hordeum vulgare* extract in its solution. Cell numbers of each group will be periodically measured (bi-weekly) and averaged using a spectrophotometer and compared to the control growth rate. Since barley extract has been shown to inhibit pigment photosynthesis of similar dinoflagellates (Owen, D. P. 2019), the experimental group should show significantly inhibited growth by the addition of *Hordeum Vulgare*.

Weston High School

Teacher: Stacey Greenberg

Project # 86

Chaudhry, Haseeb

Using Named Entity Recognition to Identify and Predict Immunoglobulin Gene Patterns

Research Proposal, Physical Science

Immunoglobulin genes (IG genes) are proteins used by the immune system that recognize antigens such as bacteria and viruses and neutralize them. Identification of these genes is prone to many human errors. Accurate detection is most promising through computer programming. An example of this is using Named Entity Recognition (NER) in spaCy, a module with many language processing functions. NER detects phrases such as persons, organizations, locations, etc. This project will use the spaCy NER module in Python 3, a programming language, to identify and predict IG gene patterns in scientific abstracts. Criteria for this project are that the algorithm must be able to recognize IG gene types 75% of the time and at least 100 types of IG genes. 1000 abstracts have been selected by the mentor from the PUBMED database. 500 of these will be used for training the algorithm. A Python program will match these abstracts to gene symbols using string manipulation. After that, some context before and after the symbols will be collected and used to train the NER model. After training, the 500 remaining abstracts will be used for testing. The data analysis technique will be an accuracy test, to see if the results of the NER model are significant and if it can detect IG gene patterns accurately. The implication of this project is that it will make detecting patterns of IG genes in scientific abstracts and other literature much more accurate and efficient.

Amity High School

Teacher: Catherine Piscitelli

Project # 87

Chauhan, Maya

Comparing the Effects of Remote Therapy on Media Platforms to The Effects Received Through In-person Therapy

Research Proposal, Behavioral

Remote therapy is becoming a more significant part of life in the modern age, but it can have many different impacts than face-to-face therapy. There were a lot of things put into consideration when online therapy first became an option of treatment for people in need. The purpose of this project is to understand why some people prefer online therapy rather than in-person therapy, and vice versa, and to look at the effectiveness and limitations of both the types. It is important to look at what type of therapy each individual prefers because everyone has different situations they are comfortable with. The plan is to research more on certain online therapy platforms, like BetterHelp, and understand how the therapy process works. If possible, there will also be questionnaires sent out to a group of teenagers undergoing therapy. The questionnaire will consist of specific statements about the types of therapy that will be made using the research collected about each type. For example, the survey might have questions about the specific kinds of environments provided by the therapist. The people taking this survey will be asked to select their more preferable statement for each question. In the end, it is expected that remote therapy will be very beneficial, but it will still limit some of the aspects that in-person therapy does not.

Ridgefield High School

Teacher: Patrick Hughes

Project # 88

Chen, Rebecca

The Effects of Social Media Breaks on Cognitive Reading Comprehension

Research Proposal, Behavioral

Social media usage has been exponentially increasing within the past decade. However, with the growth of social media, comes issues regarding their impacts on academics. The purpose of my experiment is to specifically target the area of reading comprehension and whether it is affected by social media breaks. I hypothesize that social media breaks will not serve as a proper way for the brain to rest and will decrease reading comprehension performance. My approach to this experiment would be having a control group who will simply read a passage and directly answer correlating questions. I will then have an experimental group of students who will read the same passage but then take a 10-minute social media break prior to answering the questions. Variables such as a student's reading level, students from the same school, same passage, same questions, and social media platforms will be kept constant. My prediction is no social media break time will be the most adequate because it allows for immediate comprehension after the passage is still fresh in a student's mind. I also predict that social media breaks distract a student's mind from the passage they had just read, decreasing their accuracy. To evaluate my hypothesis, I will analyze the data by seeing if a ten-minute social media break or no social media break had the most accuracy among the questions. This experiment will assist students in performing their best potential in heavily dependent reading comprehension subjects.

Amity High School

Teacher: Catherine Piscitelli

Project # 89

Cheng, Alicia

Developing a Low Cost Well Water Filtration System for Rural/Low Income Households

Research Proposal, Physical Science

Many non-urban families use well water, and some of those households may not have the resources to regularly test and check their water for contaminants that decrease the quality of life. The purpose of this project is to design, build, and test a cost-effective, multi-layer well water filter that can reduce harmful contaminants and other health risks. By incorporating different water filtration methods and filters into one system, the weaknesses of one specific type of filter can be reduced or eliminated entirely. The first layer will be a sediment filter that filters out dirt and sand. A UV light that kills bacteria will be added, and then an activated carbon filter that removes chlorine and pesticides. Because the filter can't be tested on a functioning well water system in a house, the filter will be built on a smaller scale to model the effects. To test, unfiltered well water from the drain valve will be taken, pumped through the filtration system, and tested with a well water testing kit. The results will be compared with the filtered water from the faucet. It is projected that this filter will do better in filtering different chemicals, bacteria, and heavy metals that are tested by the well water testing kit, compared to the filtered water from the whole house sediment filter. This filter can help reduce the risk of contaminated well water at a reasonable cost. This reduces the need for testing, which is often ignored or forgotten by these families.

Amity High School

Teacher: Catherine Piscitelli

Project # 90

Costello, Isobel

Investigating the effect of moderate to intense aerobic and anaerobic exercise on oxygen saturation, visuospatial task performance, and short term working memory: implications for female student athletes ranging from sixteen to seventeen years old.

Research Proposal, Health & Medical

The study of the effect of moderate to intense anaerobic and aerobic exercise on cognitive function is important because studies have shown that different types of physical training directly impact cerebral capacity. However, little is known about the cardiovascular effects of different training intensities on short term working memory. The purpose of this study is to compare the effect of moderate to intense anaerobic and aerobic exercise on the short term working memory of 16-17 year old female student athletes. Twenty female student athletes ranging from 16-17 years old will be divided into two groups; one group will perform anaerobic exercise and one group will perform aerobic exercise. The participants' heart rates will be recorded to validate and prove the different cardiovascular intensities. Oxygen saturation levels will be measured with pulse oximeters. A viso-spatial task exam that targets short-term working memory will be taken before and after the exercise. The results of the short-term working memory exam performance will be compared among the two groups. It is predicted that the anaerobic exercise will produce lower levels of oxygen saturation, higher heart rate levels, and decrease the function of the participants' short-term working memory. If my hypothesis is correct, the anaerobic participant data will show that oxygen deficit during recovery periods is associated with a lower score on the visuospatial exam. This study will allow athletes to make better decisions regarding how specific cardiovascular intensities affect their application of short-term working memory in the classroom.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 91

Cox, Lydia

The Incorporation of Beneficial Microorganisms for Corals (BMC) into sunscreen as a successful way to distribute BMC to protect against post traumatic heat syndrome and bleaching

Research Proposal, Environmental

Post Heat Stress Syndrome is a huge problem among corals. When exposed to long periods of heat stress, oftentimes they end up bleaching and dying. Scientists in Rio De Janeiro experimented with beneficial microorganisms for corals (BMC) that help reduce environmental stress. This experiment would test to find a way to distribute BMC through Reef-safe sunscreen. There are a number of preliminary items that need to be tested to see if this is possible: Can the BMC survive in sunscreen, does BMC negatively affect human skin, does BMC negatively affect the environment? If these tests yield positive results, we would explore different ways to distribute the BMC in the water and see if it is still effective at reducing Post Heat Stress Syndrome. These would include immersing a mannequin arm with sunscreen applied into a saltwater tank for 60 minutes not moving, the amount of sunscreen dissolved in the water will be tested. This step would then be repeated with BMC in the sunscreen. Next, the mannequin arm with sunscreen on it would be placed in a saltwater tank for 60 minutes moving. This would be repeated with sunscreen containing BMC. If these prove beneficial then a BMC/sunscreen combination could be a way to distribute the BMC into the ocean close to the affected coral.

Newtown High School

Teacher: Timothy DeJulio

Project # 92

Crist, Molly

Analyzing The Impact Of COVID-19 On The Amount Of Happiness Found In Nature As Shown On Social Media

Research Proposal, Behavioral

COVID-19 has greatly changed how people find happiness because many people were not able to see friends and family, travel, or go to school or work. These are things people would normally find happiness in, but were not able to with the restrictions of COVID-19. The purpose of this study is to help determine how the amount of happiness found in nature has been impacted by COVID-19 as shown on social media. A social media analysis will be conducted to assess how the amount of happiness found in nature may have changed because of COVID-19. Code will be used to determine the percentage of posts with words that correlate to happiness such as happy, joy and excited of the amount of posts with the word "nature", from both before and during COVID-19 and compare This experiment has not been conducted so there are no results. However, the expected outcome is that people found more happiness in nature during COVID-19 as a result of having less ways to increase happiness. This would be shown by a higher percentage of happiness words included in posts about nature. This research will further our understanding of the impacts of COVID-19 on social-emotional wellbeing. Much is still not known about how COVID-19 has affected the world and the lives of individual people. This research will also give us a better understanding of how important nature is to well-being.

Ridgefield High School

Teacher: Ryan Gleason

Project # 93

Crosby, Cody

The effect of different substrates on Pleurotus ostreatus mycelium insulation packaging as an expanded polystyrene alternative

Research Proposal, Environmental

The lightweight, cheap, and insulative properties of expanded polystyrene, or styrofoam, have designated it as the material of choice for shipping and a variety of other uses. However, styrofoam's effects on the environment, ecosystems, and human health are extremely hazardous, especially because the material is not biodegradable (Ehrenberg, 2009). Mycelia is a pertinent alternative to styrofoam because of its structural integrity along with its insulative properties when dried. While numerous private companies have utilized mycelia to make material, there is limited information on how substrates used in the growth process can affect insulative performance. This study's intention is to grow *Pleurotus ostreatus* fungi with five different organic waste substrates and evaluate how this affects insulative capabilities. Growth mixtures will be prepared by combining pasteurized substrate, supplement, and grain spawn, which will then be packed into 3D printed box molds that have identical dimensions to the expanded polystyrene container (the control). Box molds will be tested by comparing the slopes of cooling water over time as well as calculating the specific heat capacity of each container (higher specific heat will signify better insulative properties). Based on previous research done on how organic substrates affect mycelial yield, corn cob substrate will be the most comparable competitor to polystyrene insulation because of its ability to produce a high yield of mycelium during growth (Koukhi & Tahat, 2015). A higher yield of mycelium will most likely result in a higher density material; denser materials have lower thermal conductivity and therefore are more effective insulators.

Weston High School

Teacher: Stacey Greenberg

Project # 94

Crowley, Isabella

The Effect of Regular vs. Non Regular Exercise on Mood and Anxiety of Adolescents

Research Proposal, Behavioral

Regular exercise participation is known to have both psychological and physical benefits. However, there is limited amount of research on the effect of different exercise habits on one's mood and anxiety. Even less research in this area involves adolescents. The focus of this study will be to find what effect regular exercise vs. non regular exercise has on mood and anxiety in adolescents by the use of a mood/anxiety based task after an acute session of aerobic exercise is performed. A form will be distributed to participants who will then fill out an exercise participation questionnaire, the results will identify them in either the regular exercise or non regular exercise group. Mood and anxiety will be assessed with The State-Trait Anxiety Inventory or The Exercise Induced Feeling Inventory. Participants will record their responses before any exercise is performed (baseline), immediately before exercise, immediately after exercise, and 25 minutes after exercise. All participants will perform the same type of exercise for the same duration. It is hypothesized that those who exercise regularly will report positive mood and a decrease in anxiety while those who do not exercise regularly will report an initial decrease in mood and increased anxiety, then return to their original mood states 25 minutes post exercise. Positive mood as a result of exercise can induce future exercise participation which is known to be beneficial to one's health. Additionally, this research can be beneficial in managing anxiety symptoms by inducing the correct duration and intensity of exercise.

Ridgefield High School

Teacher: Patrick Hughes

Project # 95

D'Amico, Nicholas

An analysis of geometry influences material strength

Research Proposal, Physical Science

In a product, geometry of load bearing parts plays a large role in overall strength. In the engineering of load bearing products, many different shapes and geometries can be used to create a strong part. The issue in designing a part, is finding the geometries that are strong while keeping weight and material usage to a minimum. To find the most efficient geometries, a part will be designed using CAD. The basic geometries of load bearing areas will then be altered while keeping the same functionality. The parts will be stress tested within CAD and compared to physical stress test results of the same part. The results from the CAD test and the physical test will then be compared. With the results from the physical test, and CAD test, each part will be compared. The basis for comparison will be: the part strength ratings (newton meters), and part weight (grams) . The part geometry with the highest strength to weight ratio will then be deemed most efficient. The physical part will be 3D printed in a controlled environment with controlled parameters.

Newtown High School

Teacher: Timothy DeJulio

Project # 96

Dallemule, Angelina

Anxiety Sensitivity and Intolerance of Uncertainty Promote Correlations Between Generalized Fear and Maladaptive Avoidance in Participants with High Anxiety

Research Proposal, Behavioral

A relatively recent form of assessment, APIC-G, is a lab-based way of testing Pavlovian generalization. With fear-based generalization comes maladaptive avoidance of any similar stimuli, which can lead to a chronic issue in due time. This fear generalization that resembles danger cues is widely correlated with anxiety disorders, shown through few studies (Hunt 2019). This study will aim to look at anxiety sensitivity (AS) and intolerance of uncertainty (IU) in those with high anxiety- who score between 45 and 80 on the State-Trait Anxiety Inventory test (STAI). This aimed to figure out the extent to which AS and IU positively moderate the strength of relations between fear-generalization and maladaptive decisions in participants with high anxiety. Anxiety sensitivity can be simply defined as the “fear of fear,” while intolerance of uncertainty is the fear of anything ambiguous. This study will be done using self-evaluations as well as EMG measurements of blinking, to measure the startle level in each participant. It is predicted that with the increasing anxiety scores, the levels of both IU and AS will increase, and will be significantly higher than their low-anxiety counterparts (Hunt 2019). Even before a conditioned danger cue (CS+), it is predicted that AS and IU levels will be high. IU is also predicted to facilitate APIC-G or lab-based generalization measures. By understanding connections between generalization and anxiety symptoms, professionals can better aid those suffering from chronic stress using treatments like fear hierarchies or discrimination training.

Darien High School

Teacher: David Lewis

Project # 97

Daly, Maura

Visualizing functional magnetic resonance imaging (fMRI) data through AR and 3-dimensional rendering

Completed Project, Health & Medical

Nearly 1/6 of the world's population, nearly one billion people suffer from a neurological disorder, from brain injuries to Alzheimer's to Parkinson's disease. Functional magnetic resonance imaging utilized with immersive technology, treatment and detection can become more streamline. fMRI evaluates brain activity by identifying changes in blood flow, this method is reliant upon the correlation between cerebral blood flow and neural activity. The primary purpose for a fMRI scan is to map a patient's brain before surgery, the brain's activity is mapped into squares called voxels, representing the hundred of neurons and tissue inside the brain. Therefore, by creating this illustrative map doctors will better understand the regions linked to crucial functions, such as walking, speaking, talking, etc. The typical fMRI assessment requires a visual, auditorial, or other form of stimuli, in order to induce certain neural states of the brain. Once an image is acquired, displaying a neural stimuli, AR or 3-dimensional rendering can be implemented. Through this technology the depth and complexity of a scan can be conveyed in greater detail, in comparison to limiting 2-dimensional. AR creates a rich and interactive experience within surgery, teaching, and simplifying treatment plans to patients. AR technology has been proven to increase learning retention and is more impactful than other forms of visual or textual representation. When utilizing fMRI data in conjunction with AR technology, overlaying scans and models onto a surgical field will help a surgeon determine the best course of action for the patient. Consequently, limiting recovery time and generating better outcomes.

Newtown High School

Teacher: Timothy DeJulio

Project # 98

Darby, Lindsey

Analyzing the Differences of Reading Comprehension between Reading Technologies (Audiobooks and TTS) and Print Reading

Research Proposal, Behavioral

As reading technologies, like audiobooks and Text-to-Speech (TTS), become more popular, it's important to understand the differences and effects each type can have on learning. Recently, studies have shown that nearly 50% of students use at least one audiobook throughout a year. Audiobooks are professionally taped recordings of texts, sometimes read by actors. TTS, however, uses a computer algorithm and automated voice to translate a digital text into audio. Despite confusion between these technologies, inconsistencies in students' comprehension scores have been found. Furthermore, how do these technologies compare to paper reading? The goal is to determine if there is a difference in comprehension scores between the type of listening style. The two methods of listening use an audiobook and TTS of the text. A third method will also be included as a baseline of reading comprehension, where participants read a paper copy of the text. Comprehension scores of readers listening to an audiobook, listening to TTS, and reading a paper copy of a single text will be recorded. Then the findings will be statistically analyzed using the Mann-Whitney U and Kolmogorov-Smirnov tests to guarantee a significant statistical difference between results. After the data analysis, it's expected the TTS method will have the lowest comprehension score when compared to the reading from paper and audiobook method. Additionally, no significant difference between audiobooks and reading from paper is hypothesized. Results will allow for a better understanding of the difference between reading technologies, along with highlighting the tools that help students learn effectively.

Darien High School

Teacher: David Lewis

Project # 99

Di Capua, Jennifer

Facilitating Healthcare Access for Latinx Immigrants Using a Novel Smartphone Application

Research Proposal, Behavioral

The purpose of this study is to develop a smartphone application aimed at connecting healthcare providers with the Latinx, documented and undocumented, immigrant population. As many as 12 million immigrants are undocumented in the United States. This population has limited choices when seeking healthcare, particularly during the COVID-19 pandemic. It is hypothesized that immigrants will be more likely to access healthcare when provided with information through an app. This study will focus on Latinx immigrants in New Rochelle, New York. A group of immigrants have been surveyed in either English or Spanish at sanctuary sites to uncover barriers to healthcare. The survey showed that the main barriers include cost, legal status, lack of insurance, and language. I will use the data from the survey to create an application, for Apple and Android, that addresses the barriers identified. The specific coding language is Microsoft C# and the mobile app uses Microsoft Xamarin Forms. Another survey will be deployed to the same group of participants to gather feedback and assess their likelihood of utilizing the application to access healthcare in the future. It is expected that immigrants will report on the survey that they are more likely to use the application to access healthcare. The possible results of this project could help me prioritize addressing specific barriers immigrants face during COVID-19 in future research. In addition, the results can help inform policy decisions about widening access to healthcare.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 100

Dillon, Avery

Creating an underwater GPS for extreme depths

Research Proposal, Physical Science

Underwater GPS can only go a few meters deep without losing signal from satellites. Satellites use microwave signaling to reach the GPS. The smallest microwave is the C band at 1 cm, which is easily absorbed by water. The W band is the largest at 10cm, and isn't easily absorbed by water. It's nearly impossible to triangulate the location of the GPS when the satellite signals are absorbed. The mentor and the student will make a software system that will transfer the C bands into W bands so the GPS signal can be reached far underwater. This software does not currently exist. "MatLab" is the programming software that the student will use, with the guidance of the mentor, to create new software. The first objective is to make sure that the signals were transferred using a GPS. The next step is to test the system underwater by having a GPS underwater at different depths and having the satellite booster on the surface of the water. the student will then check to see how deep the signal will go with and without the software on the satellite booster. The mentor and student will then collect data from the testing process for analysis. This project will make it safer for scientists to travel in the ocean by allowing more precise locations to be shown, and this project can also make it easier for scientists to discover more of the ocean.

Amity High School

Teacher: Catherine Piscitelli

Project # 101

Donovan, Chelsea

Small molecule compound inhibits the effects of Six1 on tumor growth and metastasis via angiogenesis and tumor associated macrophages (TAMs) in colorectal cancer

Research Proposal, Health & Medical

Colorectal cancer is the second leading cause of death in the United States. Previous studies have found that the overexpression of oncoprotein Six1 leads to an increase in cancer growth and metastasis through the stimulation of angiogenesis and the recruitment of tumor-associated macrophages (TAMs). The goal is to find out if the small molecule compound NCGC00378430 (abbreviated as 8430) can significantly reduce the effects of Six1 in colorectal cancer (CRC). In this experiment, mouse models would be used to see the effects of 8430 on CRC growth via angiogenesis and TAMs. Mice will be split into 4 groups, all receiving the mouse colon adenocarcinoma cell line MC38. There will be a MC38-Ctrl group receiving a placebo, MC38-Ctrl group receiving 8430, MC38-Six1 group receiving a placebo, and a MC38-Six1 group receiving 8430. The data will be analyzed using immunohistochemistry, wound healing/cell invasion assays, western blot analysis, real-time PCR, and analysis of tumor tissues for size and weight. It is expected that a significant reduction in tumor angiogenesis and TAM expression will occur in the MC38-Six1 group receiving the small molecule inhibitor 8430. The data obtained from the experiment will demonstrate the extent to which 8430 can pharmacologically inhibit Six1 and reduce the oncoprotein's effects on tumor growth. Furthermore, this study will provide key information to support the use of 8430 as a novel inhibitor to cancer growth and metastasis.

Darien High School

Teacher: David Lewis

Project # 102

El-Masry, Claudia

Analyzing Single Cell RNA Sequencing Data to Determine Immune Cell interaction with Cardiac Tissue that Could Contribute to Myocarditis

Research Proposal, Health & Medical

Myocarditis is an inflammatory cardiac disorder. Severe cases of myocarditis can lead to permanent damage to the heart's tissue, which can lead to heart failure. This project seeks to analyze and determine patterns in immune cell function to identify if there is a correlation with the development of myocarditis. It is hypothesized that the IL-1 will be overexpressed in the datasets when looking at data taken from patients with myocarditis. First, I will export the anonymized data from the database. I will then clean the data and put it into R Studio, where I will then transfer the data into box plot graphs to compare the RNA sequences from myocarditis patients to the sequences from healthy patients. I will then look for statistically significant differences using ANOVA. I expect to see the increased presence of lymphocytic CD4+T and CD8+T cells, signaled by the self-antigen presenting dendritic cells to produce proinflammatory cytokines since I will be looking at myocarditis patients and these are characteristics of the disease. I also expect to see overexpression of IL-1 in the datasets as well. This data can aid medical professionals in identifying patients that are more likely to have this immune dysfunction, which may allow them to treat them earlier and lead to new developments in treatment.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 103

Elbaqi, Fatima Zahra

Transmissible cancer identified in two marine mussel species in South America and Europe

Research Proposal, Environmental

Transmissible cancer is a rare phenomenon in which cancer cells or a cluster of cells themselves act as infectious agents, which can be transferred between individuals without the involvement of an infectious agent. Disseminated neoplasia, which is a diffused tumor of the hemolymph system and one of the 6 most destructive diseases (among bivalves) has been affecting two geographically distant populations of bivalve species. The Chilean Mussel of South America (*Mytilus Chilensis*) and the Blue Mussel of Europe (*Mytilus Edulis*). Cancer from these two species of mussels is very similar. The objective of this literary-based study is to evaluate the lineage of this cancer to show that the same lineage of cancer infects both species and has somehow been transmitted from South America to Europe.

Darien High School

Teacher: Christine Leventhal

Project # 104

Finamore Gazal, Giovanna

the effect of dual language immersion vs one way transitional immersion programs on metalinguistic awareness and same restart cost

Research Proposal, Behavioral

In the United States, 20% of the population is bilingual. This project seeks to determine the best form of bilingual education by first testing whether participants in dual language immersion programs have an increase in metalinguistic awareness and reduced restart switch costs in comparison to participants in single language immersion programs. It is important that this research is done in order to ensure that programs found in schools don't lead to subtractive bilingualism. I plan on having at least 15 participants for the dual language immersion program and at least 15 participants for the single language immersion. Participants will be children between the ages of 5 and 7 because most people taking part in these programs are children. I would also make sure that participants have no known neurological problems or health problems, as well as normal hearing and vision. It is also important to control the educational backgrounds of the participants as well. I plan on using a test to examine orientation, memory, and attention, as well as the ability to name objects, follow verbal and written commands, and copy a complex shape like the mini mental state exam. Higher scores on this exam will show an increase in metalinguistic awareness and a decrease in restart switch costs. I expect the students that participate in dual language immersion programs will perform better on these tests than those who participate in a one-way transitional immersion program. Thus, I expect the dual immersion program students to have an increase in metalinguistic awareness and a decrease in restart cost. This research would point to further avenues in bilingual education and would help educators to determine the best method of acculturation for students into an English-speaking classroom. Some limitations of this study are that I am only able to test a few people as opposed to many. Some implications of this study include determining whether single language immersion or dual language immersion programs are most beneficial to bilingual students learning a new language.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 105

Fitzgerald, Cora

Testing Various Delivery Systems to Hepatic Cells using CRISPR-Cas9.

Research Proposal, Health & Medical

CRISPR-Cas9 is a new tool to treat incurable diseases, but its application in cancer treatment has been hindered by low editing efficiency in the tumors, and the potential toxicity of delivery systems. The PCSK9, Apolipoprotein C3, and PLK1 genes are all present in the liver and are considered oncogenes. Finding the most efficient oncogene to target using CRISPR, and the right delivery system will increase editing efficiency, and help treat diseases. Electroporation is a delivery method that uses an electrical pulse to pass nucleic acids into cells. It is the most common delivery system for Crispr, but has showed low editing efficiency in the liver. I propose an analysis of various delivery systems to multiple genes involved in the growth of liver cancer. The first step I would take is to collect data on experiments using Electroporation, Lipid Nanoparticles, and Polymeric nanoparticles on Hepatic genes. I would consolidate the data, and come to a conclusion about the best combination for CRISPR. I would do further research on the genes and delivery systems function to back up my conclusions. I would expect Lipid nanoparticles delivering to the PLK1 gene to have the highest editing efficiency. This is due to LNPs nontoxic and potent transfection. The PLK1 will be the best gene to target. Its vital role in mitosis makes it common for overexpression, and will have the greatest impact if made curable. The implications of a successful use of CRISPR in the liver could treat, and even cure liver cancers.

Ridgefield High School

Teacher: Aine Kapell

Project # 106

Florio, Lia

Comparing Phragmites australis as Mason Bee Nesting Material versus Wood

Research Proposal, Environmental

The invasive reed plant *Phragmites australis* has overtaken the lush swamps of Ridgefield's beloved Woodcock Nature Center. Although there are projects working to eliminate this species, the phragmites leftover from these projects remain without a purpose. Connecticut also struggles with bee populations stricken with pests and pesticides, namely mason bees which are a native species of indispensable pollinators. A way to improve both of these problems is by assessing whether mason bees prefer phragmites reeds or store-bought wood blocks as nesting material in their homes, as phragmites have a similar structure to the store-bought nesting material. This experiment will consist of 3 trials comparing the abundance of bees nesting in wooden mason bee homes versus homes made of natural phragmites reeds. The quantity of mason bee cocoons laid in each home will be counted at the end of the season. If the results indicate a larger or equal abundance of mason bee cocoons in homes made of *Phragmites australis*, building mason bee homes can become more popular and economically efficient because people can build homes with phragmites instead of purchasing expensive nesting material from the store. Building bee homes can become an easy project to simultaneously make use of the invasive species while providing habitats for the essential pollinators.

Ridgefield High School

Teacher: Ryan Gleason

Project # 107

Foley, Annabelle

Analyzing previous and current CRISPR-based treatments for Huntington's Disease with the goal of developing a new treatment

Research Proposal, Health & Medical

Currently, Huntington's disease(HD) is incurable, despite the efforts of numerous clinical trials. Huntington's disease is a hereditary neurodegenerative disease. The disease is determined by the huntingtin (HTT) gene. Mutations in the HTT gene cause the onset of Huntington's disease. The large role genetics play in the onset of HD makes Huntington's disease a good candidate for CRISPR based genetic engineering treatments. CRISPR is a relatively new method of gene engineering that allows genes to be found, edited, and/or replaced. CRISPR treatments have the potential to treat HD both after diagnosis and before symptoms begin to show. However, there have been various unsuccessful trials attempting this treatment. This project will attempt to find a detailed way to use CRISPR treatments in treating HD by analyzing past and current experiments/ trials in this area of research. This data will be compared and analyzed with the goal of finding the flaws in each trial, combining the information, and developing a plan for how future experiments can succeed in the treatment. This project will look at Huntington's on both a genetic level and a larger scale by analyzing any brain scans and gene sequences included in past experiments. This data will be compiled and any insight will be thoroughly recorded throughout the course of the research process. A conclusion will be drawn from this data analysis about the potential applications of CRISPR-Cas9 in treating Huntington's disease.

Newtown High School

Teacher: Timothy DeJulio

Project # 108

Gaaserud, Ellie

A Deep Learning Based Fusion Classifier for Prediction of Adverse Ascending Aortic Events

Research Proposal, Health & Medical

Aortic dissections cause more than 13,000 deaths each year. Prior to dissection, aortic aneurysms are asymptomatic, so early detection is difficult, necessitating a way to determine which patients are at risk. Currently, the aortic diameter is primarily used to risk-stratify patients, but diameter is a two-dimensional measurement and does not account for three dimensional architecture of the aorta. This study seeks to develop a fusion deep learning-based algorithm using pixel-level data from thoracic CT scans in order to create an improved risk classifier for patients with ascending aortic aneurysms. A cohort of patients with CT scans available with confirmed ascending thoracic aneurysm will be selected using the database at the Yale Aortic Institute. The entirety of the thoracic aorta will be manually segmented on CT scan data from the aortic root to the renal arteries on a subset of patients. A U-Net architecture will be trained, and that algorithm will be used to segment the remainder of the patients. A 3D convolutional neural network will fuse the resulting binary three-dimensional aortic map with applicable clinical data obtained from each patient to predict adverse events. Again, an 80/20 train/test split will be applied to the dataset. The applicable outcomes will be type A dissection and aortic-related deaths. First, the performance of the U-Net segmentation model will be evaluated using the Jaccard index, then the fusion classifier will be evaluated using an AUROC analysis. The deep learning classifier is expected to outperform diameter alone as a prediction metric.

Darien High School

Teacher: Christine Leventhal

Project # 109

Gannon, Charlotte

Analysis of Cancer Diagnosis Prevalence in Witnesses of the Attacks on September 11, 2001

Research Proposal, Health & Medical

The attacks of 9/11 exposed the general population of Manhattan to a dust cloud that contained carcinogens. While there is research on the effects of the dust cloud on first responders, minimal research has been conducted focusing on witnesses. The purpose of this study is to investigate the incidence of selected cancers in Manhattan resident witnesses after exposure to harmful chemicals in the dust cloud. I will use the cancer registry from the World Trade Center (WTC) Health programs as a source of data. All data must come from participants that have lived in Manhattan during the time period studied, between 2001 and 2016. The data will focus on cancer incidence of residents living below Houston Street for five, ten, and fifteen years post-exposure. The cancer incidence will be compared with the cancer incidence of residents living in upper Manhattan (above Houston Street). Controls include no history of smoking or cancer in the family. In this study, I expect to find a significantly large number of witnesses with cancer diagnoses. I anticipate that exposure time (5, 10, 15 years) will be associated with cancer incidence, through using relative risk ratios. This study points to further avenues of research to focus more on the witnesses that were not directly involved as first responders and how the dust cloud had further effects on the general health of the public. It can inform decisions about the impact of air quality in the future and possible evacuation times.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 110

Gaynor, Nathan

How does the free floating brown dwarf population compare with the brown dwarf companion population (both transiting and non-transiting)?

Research Proposal, Physical Science

Brown dwarfs are substellar objects that are unable to fuse hydrogen in their cores. Brown dwarfs can be found free floating in space on their own, or around an actual star. The differences between free floating brown dwarfs and brown dwarf companions are relatively undocumented. Research is often done for each type specifically, but comparisons between the two have not been found. An analysis comparing the two types of dwarfs will be done using already published data. This analysis will be a comparison of the stellar parameters of the objects, such as effective temperature, metallicity, surface gravity, mass, radius, and age. These parameters will be compared and graphed, and correlations between different parameters will be found. The comparison will find differences between the two brown dwarf populations; implications and conclusions will be drawn from there. This research will improve current understanding of the formation patterns of brown dwarfs, seeing if there is a difference in how free floating brown dwarfs and brown dwarf companions are created. The research will also aid understanding of brown dwarfs as a whole, which also helps the knowledge of exoplanets. This type of research will advance the current model of the universe and how it functions.

Ridgefield High School

Teacher: Ryan Gleason

Project # 111

Genger, Nily

Hydrolizing PET and PEF plastics using PETase in *Chlamydomonas reinhardtii*

Research Proposal, Environmental

Everyday, eight million pieces of plastic make their way to the ocean. Taking up to 450 years to decompose, this plastic spreads toxins, damaging Earth's wildlife. Moreover, burning plastic pollutes the air and contributes to global warming. *Chlamydomonas reinhardtii* offers a promising solution to this problem, as it contains the enzyme PETase. PETase can break down plastic chains into monomers, and *Chlamydomonas reinhardtii* can eat both PET and PEF plastic. In this experiment, *Chlamydomonas reinhardtii* (algae) will be cultured and fed pieces of PET and/or PEF plastic, and the mass of the plastics will be assessed every day for nine days. Then, using advanced calculus, the rate at which the plastics get eaten, as well as the rate that a single alga eats plastic will be calculated for both types of the plastic. The outcome of this experiment will likely indicate that the algae eats PEF plastic faster than PET plastic because its molecular structure allows it to hydrolyze faster. This project will likely offer a way to solve Earth's plastic crisis by identifying natural ways of breaking down plastic and suggesting which plastics are better to use, as they break down more efficiently. Additionally, the byproducts of this plastic consumption are materials that can remake plastic, affording natural ways to recycle plastic while providing sustenance to aquatic life. Overall, this project holds great promise for decreasing Earth's plastic crisis.

King School

Teacher: Victoria Schulman

Project # 112

Gupta, Aditi

The Effect of Black Raspberries on Pancreatic Ductal Adenocarcinoma and Tumor Size

Research Proposal, Health & Medical

Pancreatic cancer is a common form of cancer in the U.S.; 93% of cases are instances of pancreatic ductal adenocarcinoma (PDAC), which occurs in the lining of the ducts in the pancreas. It has an extremely low survival rate of 9%. The most common initiating event of PDAC is the activation of the KRAS gene. PDAC is characterized by low quantities of immune cells, such as CD8+ T and NKp46+ cells, which provide defenses against tumor cells. Black raspberries (BRBs) have high levels of chemopreventive components such as anthocyanins, ellagitannins, and dietary fiber. These components inhibit cell proliferation and angiogenesis, leading to cell apoptosis; they also lead to a decrease in KRAS activation. It is hypothesized that the intake of BRBs will lead to a decrease in the size of pancreatic tumors. Mice will either be fed the control diet, which is the AIN-76A diet, or a modified version of the control diet containing 5% BRBs. After 8 weeks of administering this diet, pancreatic tumor tissues will be collected for examination. These tissue samples will be used to determine the decrease in tumor volume. It is predicted that the addition of BRBs to the diet will lead to a significant decrease in the size of the tumors, as well as increasing CD107a levels and the number of immune cells, such as CD8+ T and NKp46+ cells. These projected results could lead to the development of new dietary plans for patients to help improve their chances of survival and overall health.

Ridgefield High School

Teacher: Ryan Gleason

Project # 113

He, Angela

Analyzing the Inter-Annual Variability and Changes of Summer Precipitation Intensity in Various Connecticut Cities Over the Past Eight Decades

Completed Project, Environmental

Connecticut precipitation models have shown a clear increase of summer precipitation intensity between 1970-2099. This is due to the increasing amounts of greenhouse gasses in the atmosphere, resulting in increased temperature and moisture holding capacity in the atmosphere as well as an increase in urban flooding occurrences. In Connecticut cities, flood drainage designs are required to alleviate street flooding after a storm with a magnitude that occurs once every 10 years. The purpose of this study was to analyze the precipitation data collected in the past eight decades to determine how extreme precipitation events in several areas of Connecticut have changed over time and how this change is related to increasingly frequent urban flooding. It was hypothesized that this analysis would show an increase in intensity over time, and that this was also a large factor in increasingly frequent urban flooding. Data analyses thus far support this hypothesis. The independent variable in this study was time, and the dependent variable was precipitation intensity. This study used data from databases, such as Climate Engine, and station data collected by the mentor various Connecticut cities. The data was split into specified year intervals to find the magnitude of each group's return period. These analyses were done individually for each database for each city using Microsoft Excel and then compared. Analyzing Connecticut's variability and change in precipitation intensity could help predict its urban flooding and drought risks. With this information, cities will be able to create more safe, accurate flood design criteria.

Amity High School

Teacher: Catherine Piscitelli

Project # 114

Hicks, Cate

A warmer climate and its effects on pollination

Research Proposal, Environmental

A warmer climate and its effects on pollination 1. As anthropogenic-induced global change continues to threaten our biodiversity, it also affects pollination and mutualistic plant-pollinator interactions. These interactions are extremely important to both humans and nature. Pollination is essential to crop productivity and functioning ecosystems. Climate change impacts factors such as species distribution and diversity, creating temporal mismatches between mutualistic partners like pollinators and plants. 2. To approach this issue, the methodology would be to set up an experiment where the direct impacts of different temperatures (imitating the effects of climate change), could be tested, showing their direct impact on a plant-pollinator interaction. For example, different habitats with a pollinator and a plant would be set up. Each habitat would have slightly different temperatures and conditions, showing different stages of climate change. The effects on the relationship between the pollinator and plant would then be measured over time. 3. The projected results of this research I predict would show the greater the temperature and level of climate change, the more the plant-pollinator interaction is negatively impacted. 4. When conducted and concluded, this research would implicate that the effects of climate change on our biodiversity are growing, and affecting mutualistic relationships that not only benefit nature and specific ecosystems but also humans and how we survive. It would give scientists an idea of what the future of our planet may look like not only for the environment but for us as well.

Ridgefield High School

Teacher: Ryan Gleason

Project # 115

Hofstatter, Gregory

Examining the Effects of Urbanization on the Habitats of Spring Peepers

Research Proposal, Environmental

Urbanization is known to affect animals and their habitats, such as amphibians, in substantial ways. Other amphibians show this through adaptation to their changed environments. An iconic, but largely unstudied amphibian is the Spring Peeper. The purpose of this project is to examine the effects of urbanization on the habitats of Spring Peepers and eventually on the croaks and other traits of spring peeper frogs. The hypothesis is that urbanization affects the habitats of spring peeper frogs. In this experiment, the independent variable will be the levels of urbanization in a given area. The dependent variable will be the physical differences found between the habitats (water quality, pH, road distance, and pollutants in water). Habitats containing Spring Peepers will be identified and levels of urbanization will be determined (wild, mildly urban, very urban, urban) Measurements will be recorded in the selected habitats and then data will be analyzed. The mentor will provide guidance in optimal strategies for collecting and analyzing data and for the project in general, and provide any data he may have already gathered, whereas I will be collecting the data and analyzing it. Conclusions will be drawn based on the significance of the changes. This research project could provide us with a more in-depth understanding of the extent to which urbanization has affected frogs' environments, which could provide us information about other animals and ecosystems.

Amity High School

Teacher: Catherine Piscitelli

Project # 116

Holden, Bettina

Investigating the Effect of Environmental Factors on the Efficacy of Basal Bark Treatment in Preventing and Treating Hemlock Woolly Adelgid (*Adelges tsugae*) Infestation in Eastern Hemlocks (*Tsuga canadensis*)

Research Proposal, Environmental

The Hemlock Woolly Adelgid (HWA) is a pest feeding on the sap of Eastern hemlock trees since the 1920s, causing their slow decline. The Hemlock is an essential tree, creating microclimates from its dense canopies for other organisms. This study will investigate the effect of basal bark treatment and environmental factors on prevention and treatment of HWA infestation. Basal bark treatment involves spraying insecticide onto bark to avoid absorption by the surrounding environment. Fieldwork compares success rates of treated trees to untreated trees at Mianus River Gorge with point dendrometers and HWA population estimates. Treated trees will be compared to determine if differences in nutrients and soil moisture affect success rates (HWA population decline). Elemental concentrations in plant tissue will be quantified using a CHN analyzer. It is expected that basal bark treatment will be effective compared to no treatment; however, results among treated trees may vary. Measuring soil moisture and nutrients will be a proxy for water stress and tree health, providing insight regarding differing success rates. For example, greater soil moisture will increase carbohydrate levels, increasing the HWA's palpability for the tree and therefore lower success. Conversely, higher calcium and phosphorus levels may increase success since they deter infestation. The success of the basal bark treatment in this study may lead to a safer way to treat HWA infestation. Knowledge of the factors that affect treatment can lead forest personnel to control these factors, such as altering soil moisture and nutrients to improve treatment of the HWA infestation.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 117

Horn, Avery

EGFR CAR NK Cells and G-CSF as a Combinational Therapy for Breast Cancer Metastatic Models

Research Proposal, Health & Medical

Neutropenia, or neutrophil deficiency, is a prominent side effect in patients with cancer who are receiving cytotoxic therapies and is often treated with granulocyte stimulating factor (G-CSF). However, recent studies have demonstrated that G-CSF expanded neutrophils have pro-metastatic effects in the presence of natural killer (NK) cells. Chimeric antigen receptor (CAR) NK cell therapy, an emerging immunotherapy, targets a receptor on the surface of tumor cells allowing for tumor specificity and cytotoxicity. If the potency of NK cell activity is increased through CAR NK cell therapy targeting Epidermal Growth Factor Receptor (EGFR) in breast cancer mouse models, then when combined with G-CSF for neutropenia, neutrophil suppression of NK cells will be lessened while decreasing tumor size. This proposed experiment will use immunodeficient metastatic breast cancer mouse models. The CAR NK cells will be constructed using a chimeric antigen receptor and single chain variable fragment targeting the EGFR receptor. The combinational therapy of G-CSF and CAR NK cells will then be injected into the mice. Tumor growth and NK cell levels will be measured using bioluminescent imaging and flow cytometry. The expected results will show that compared to G-CSF therapy alone, the combinational therapy will decrease tumor metastatic growth as well as decrease suppression of NK cells. This proposed research would be important for many cancer patients receiving cytotoxic therapies for tumors who are immunocompromised and require G-CSF. This study would evaluate whether CAR NK cell therapy and G-CSF are effective in creating a safe and effective anti-metastatic response.

Darien High School

Teacher: David Lewis

Project # 118

Hruskar, Maya

Effect of short chain fatty acids on T-cell regulation in thymus of type 1 diabetic mice

Research Proposal, Health & Medical

Type 1 diabetes (T1D) is an autoimmune disease that arises when T-cells target and destroy insulin-producing beta cells, resulting in the body's inability to regulate blood sugar. Short chain fatty acids (SCFAs), including acetate and butyrate, are promising therapeutic supplements, having been shown to decrease disease incidence in mice. However, much is unknown about the effect SCFAs have on T-cell regulation. In this study, non-obese diabetic (NOD) mice will be fed water supplemented with butyrate and acetate over a period of 6 weeks, then killed via CO₂ inhalation. The effect of butyrate and acetate on class II major histocompatibility complex (MHCII) and costimulatory molecules expression in bone marrow dendritic cells (BMDCs) and thymic dendritic cells (TDCs), respectively, will be tested. In addition, the composition of resulting T-cell populations and their reactivity will be determined. Flow cytometry analysis will be used to examine MHCII and costimulatory molecule expression and quantify T-cell populations, and autologous mixed leukocyte reaction (AMLR) assays will be used to analyze reactivity of T-cells to TDCs. It is expected that SCFAs will upregulate MHCII expression, increase T-regulatory cell populations, and increase AMLR reactivity. If the hypothesis is confirmed, this newfound understanding of how SCFAs impact T-cell regulation could support more research on SCFAs as a treatment option.

Staples High School

Teacher: Amy Parent

Project # 119

Huber, Alejandro

Developing and Testing a Laminar Aerofoil to Apply into a Airbus A320

Research Proposal, Physical Science

In the atmosphere, Laminar flow is a state of gas where its streamline is smooth and regular. It can reduce skin friction on an aircraft, which makes up 75% of drag. The aircraft wing can shape itself in a way to reduce the aircraft's overall drag. The Airbus A320 is a low-wing aircraft. It uses about 6,400 gallons of fuel at max capacity which can cost about \$28,800 per flight. A solution to these costs is to create an advanced laminar aerofoil. This causes skin friction and fuel usage to reduce by 80%. The purpose of this project is to create an aerofoil for the A320 to reduce fuel usage and improve the efficiency of the aircraft. To do this, the scale of the aircraft aerofoil that will be implemented into the A320 must have the same proportion as the A320. This will cause the airfoil to have a maximum width of 17 inches, while the cord can be up to 4 or 5 inches. 5 different aerofoils will be modeled in Fusion360, then implemented into a CFD simulation. The 3 best-performing aerofoils will be 3d printed and then tested in a Windtunnel. Measurements to satisfy the Reynolds Number will be taken. The Airfoil implemented in the Airbus A320 will also be printed and tested as a comparison to the tested aerofoil. This will show its success. The aerofoil created can be implemented into the A320 to increase economic gain and lessen fuel consumption.

Amity High School

Teacher: Catherine Piscitelli

Project # 120

Jerfy, Aadit

AI Based Melanoma Detection System

Research Proposal, Physical Science

Melanoma, the most severe form of skin cancer, is almost always fatal if gone untreated. While it only makes up about 1% of skin cancer diagnoses, it has the highest fatality rate at 77.5% (at stage 4 over 5 years). Current detection requires a visit to a clinic to receive a physical examination or biopsy, which some people don't have access to. I propose an easier detection method that would effectively be accessible to anyone with a phone, computer, or similar device. A user interface will be made using Visual Studio code, and code written by Sasank Chilamkurthy, in which Python will be utilized to identify whether or not an image submission is melanoma. If it is, the form of melanoma will also be identified. The Python-Based AI will be trained using the HAM10000 database from harvard.edu, which consists of 10,000 images of melanoma, to train the neural network for detection. The various required variables and databases will be imported. The code will be trained to focus onto the variance in skin tone and crop the image so as to limit computing power needed. The AI will iterate through the database, comparing it to the submitted image and picking up on similarities. If there are enough characteristics of melanoma in the submitted image, it will be identified as melanoma. The code will be incorporated into an application eventually, in which people can take a picture of a lesion for accurate and simple detection of melanoma.

Newtown High School

Teacher: Timothy DeJulio

Project # 121

Johnson, Christopher

Comparing the accuracy of EEG and NIRS methods to record brain activity using cognitive-based brain computer-interface.

Research Proposal, Physical Science

Brain computer-interface (BCI) is a computer based system that acquires brain signals, analyzes them, and translates them into commands that can be used by a computer. To perform BCI, it is imperative to detect stimuli correctly and efficiently. Currently, there is little research that compares the effectiveness of different methods of detecting brain signals. To this end, the study aims to investigate how three methods of brain signal detection (alone and combined) compare in accuracy in cognitive command models. An open access multimodal brain-imaging dataset of raw simultaneous electroencephalography (EEG) and raw near-infrared spectroscopy (NIRS) recordings will be utilized to measure mean error rate classification of each detection method as well as a comparison of target signals (signals when commands were performed correctly) and non-target signals (signals when commands were performed incorrectly) of EEG 1-20 Hz, EEG 1-40 Hz, fNIRS, and best EEG + fNIRS combined. A support vector machine (SVM) will be utilized as the classification algorithm. The algorithm will create a ratio of target signals to total signals (target and non-target combined), allowing accuracy to be determined. It is expected that when EEG and fNIRS are used simultaneously, the combined signals will produce the largest ratio between target and non-target signals. Through this study, researchers will benefit from a focused discussion on improving accuracy by brain signal extraction rather than skipping straight to improving accuracy by other variables.

Staples High School

Teacher: Amy Parent

Project # 122

Katz, Miles

How adding graphene to a concrete mix's aggregate affects the mix's elasticity modulus.

Research Proposal, Physical Science

It is dangerous when concrete breaks and expensive if it is needed to repair it. A reason concrete fails to last is that it cannot return to its original shape after bearing a heavy load. The property that allows it to do this is called elasticity, and it can be altered by changing the proportions of ingredients in the aggregate. Elasticity is measured through an elasticity modulus, a formula that factors in the force applied to concrete and how much it moves to determine how bendable it is. The purpose of this project is to determine the relationship between the amount of graphene in a concrete mix's aggregate and the mix's elasticity modulus. More graphene in a mix's aggregate should result in a higher elasticity modulus for the mix. The IV is the amount of graphene added to the aggregate and the DV is the elasticity modulus. Fifteen 2mL bricks will be made, three of each mix. In each mix there will be a different amount of graphene ranging from 0% of the aggregate in the control group to 40%. The brick will be placed on the floor and a weight will be dropped on its upper face from varying heights. The measurements will be put into Young's Modulus for elasticity, uniaxial stress divided by the strain. The use of more elastic concrete mixes will decrease the frequency of concrete breaking and therefore the cost to repair it.

Amity High School

Teacher: Catherine Piscitelli

Project # 123

Kemp, Charlotte

Mapping the Connection Between Wildfires and Academic Performance

Research Proposal, Environmental

Wildfires have become more frequent, intense, and widespread in recent years. Children are heavily at risk of both the emotional and physical byproducts of wildfires. Overall, children spend more time outside. They inhale more air relative to their body weight, and fine particulate matter in the air can penetrate the body's natural defenses. On the emotional side, wildfires lead to displacement from friends, schools, and homes. Ultimately, due to the large impact of wildfires on children's emotional and physical health, it is critical to assess the connection between wildfire events and student performance. To do this, a data analysis will be conducted using AirNow.gov data to find the location and movement of wildfire smoke initially after the fire through a month later. Next, 10 points on the map will be pinned along the track of the wildfire smoke, equidistant from each other. From each of those 10 points, publicly published standardized test scores from multiple schools will be assessed for discontinuity before and after the smoke passes their respective areas. To minimize the possibility of distorted results due to other variables that would impact student performance such as school quality, only schools of similar size, socioeconomic status, curriculum, and location will be observed. Finally, for each of the 10 locations, a percent of change in scores from before the smoke enters the area and after it leaves, will be calculated. With this data, schools can make more informed decisions in improving indoor air quality in response to wildfires.

Ridgefield High School

Teacher: Patrick Hughes

Project # 124

Kieran-Mendez, Joanna

The Comparative Evaluation of VITOM and Olympus ORBEYE Exoscopes in Neurosurgery

Research Proposal, Health & Medical

Controversy surrounding new three-dimensional Exoscopes in neurosurgery led to a small number of lab studies and case reports to examine the VITOM® 3D Visualization for Microsurgery and Open Surgery or the ORBEYE 4K 3D Digital Video Microscope. Finding the right exoscope system for a surgeon to work with is crucial to how well a surgeon performs the surgery. An exoscope provides the surgeon with eyes inside of a body cavity where it can be impossible for a human to see with their own eyes. While visualization is a key factor in deciding which exoscope to choose from, ergonomics and fatigue are also the major contributors to the success of a surgery. The VITOM and ORBEYE are two of the exoscopes offered to surgeons who often need to pick between the two. The VITOM is a reliable choice and has been introduced to surgery in 2008, while the ORBEYE system is relatively new as it came out in 2019. Not much clinical data is available on the ORBEYE system. The goal of this research is to determine which exoscope performs the best in neurosurgery terms of visualization, ergonomics, and fatigue: the VITOM or Olympus ORBEYE? The ORBEYE is currently being tested in multiple fields of surgery in adults including; neurosurgery, plastics, Urology, cardiovascular. For children the ORBEYE only performs; hernia and esophageal, sequestered lung resection, cardiovascular valve repair, and living liver transplant. Methods in this study include fifteen neurosurgical procedures (5 cranial, 5 spinal, 5 peripheral nerve) the study will take place over 2 years. The surgeries will be performed by 15 surgeons (5 senior physicians, 5 consultants, and 5 residents) of varying abilities to make sure that all sets of surgeons regardless of bias contribute to an honest evaluation. After every surgery, the lead surgeon will take 2 questionnaires consisting of 13 items each, one for VITOM and one for ORBEYE. Surgical satisfaction will be increased with the VITOM vs the ORBEYE. However, the ORBEYE will score higher in both imaging and ergonomics. Overall the VITOM will be evaluated as the higher satisfaction while operating. The data will be analyzed with descriptive statistics.

Darien High School

Teacher: Christine Leventhal

Project # 125

Kosnik, Greta

The Elimination of Blood Plasminogen and the Effect on Inflammation in a Mouse Brain of an Alzheimer's Disease

Research Proposal, Health & Medical

Alzheimer's disease is a fatal cognitive disorder associated with neuronal loss and inflammation. There are two main features of AD pathology: the deposition of β -amyloid (A β) plaques and inflammation. Evidence indicates that inflammation will occur before the deposition of A β , yet the mechanism of AD pathology is still unknown. The inflammation of the brain which releases the toxic cytokines and furthers neuronal death has played a key role in the pathogenesis and development of AD. Plasminogen (PLG), which is the inactive form of plasmin (PL), is a blood protein synthesized in the liver. When PLG changes into its active form of PL, it plays a role in the regulation of inflammatory reactions. The elimination of PLG will demonstrate plasmin's ability to decrease the brain's inflammatory response. Similarly, PL in the blood will act as a regulator for the brain's AD pathology. The research will eliminate PLG in the plasma of an AD mouse model through antisense oligonucleotide technology, which modulates protein expression. The elimination serves as a comparison to an increase in PL activity through β -2-antiplasmin (A2AP) antisense oligonucleotide treatment which will increase the brain's inflammatory reaction and A β plaque deposition. The study will likely suggest that PL is the mediator of neuroimmune cell activation and AD progression, while PL also provides a link to risks in AD development. In the end, the study will also determine whether cell activation and AD progression could be stunted entirely.

Darien High School

Teacher: Guy Pratt

Project # 126

Larizza, Chloe

The Relation Between the Stock Market and Presidential Approval

Research Proposal, Behavioral

The study I created is based on how macroeconomic factors, specifically the stock market, affects the people's approval of the US president. Considering Covid-19's effect on the US economy and others worldwide, I was wondering how it impacted the 2020 presidential election. Did people elect a new president because of their uncertainty of the economy under the current one? When I got to thinking of a study, I considered how the actions of a leader can change lives so quickly, linked to the approval rate of said leader. I came to the question, how big of an influence does macroeconomics have with people's approval of the president? This led me to assume that there is a very strong correlation between the stock market and voting results. Based on recent studies, I formulated an experiment using the EPU index, a method used to study the impact of uncertainty on macroeconomics aggregates, the total amount of demand for all finished goods and services produced in an economy. The EPU index is factored out by using the voters utility function. I will use these methods with election data collected from national databases. I expect that the low points in the stock market will create a low approval of the current president, and vice versa. I also expect to learn the effect that the EPU index combined with the stock market will have on the president's approval. My research will supply an innovative process to presidential approval estimations.

Darien High School

Teacher: David Lewis

Project # 127

Lash, Camilla

Infusions of Umbilical Cord Derived Mesenchymal Stem Cells to Reduce IL-1a in Mice Models with Chronic Obstructive Pulmonary Disorder.

Research Proposal, Health & Medical

Interleukin 1 alpha is particularly one of the more irritating of the Interleukin family and it has been monitored in other infections such as SARS-CoV-2. The goal of this study is to effectively reduce symptoms of Chronic Obstructive Pulmonary Disease using umbilical cord derived mesenchymal stem cells, specifically by monitoring the amount of Interleukin 1 alpha in the lungs. The study would consist of a control group of four adult *Rattus norvegicus domestica* that will receive an infusion 50µl of terbutaline to treat Chronic Obstructive Pulmonary Disorder. The second group will receive infusions of Mesenchymal stem cells that will be sourced from the Wharton's Jelly of umbilical cords. This infusion will be directed towards the lungs. Both groups will have original recordings of cytokine Interleukin 1 alpha taken before the trials and then following five days an examination of mRNA using reverse transcription polymerase chain reaction, will be performed and the amount of Interleukin 1 alpha will be recorded. This data collection will be done again on days ten, fifteen, and thirty which will end the trials. The results are expected to show that not only do the mesenchymal stem cells significantly reduce the amount of Interleukin 1 alpha in the subjects which contain Chronic Obstructive Pulmonary Disorder, but that they also repair the damaged lungs and help the subject effectively fight the illness. The projected outcome of the results would benefit the understanding of stem cell usage and allow for new treatment for Chronic Obstructive Pulmonary Disorder.

Darien High School

Teacher: Christine Leventhal

Project # 128

Latzman, Jordana

The effect of ophthalmology NGO outreach in India on the maintenance or reduction of the rate of preventable blindness due to cataract

Research Proposal, Health & Medical

India is home to over 40% of the world's blindness population with 80.1% of blindness in India due to cataracts. Since there has been a severe shortage of ophthalmologists in India (only 15,000 in a population of 1.2 billion), many non-profit organizations (NGOs) have been intervening to impact blindness due to cataracts in India. NGO intervention rates and evidence from the literature will be analyzed to determine whether the current ophthalmologic care will be adequate in order to sustain or improve curative rates of cataract surgery in India, as the population continues to increase over the next 10 years. The rate of surgical cataract cure per year and the anticipated incidence of cataract blindness along with population growth will be modeled. Analyses will then be performed to determine how many ophthalmologists will be needed to sustain or improve the current rates (%) of cataract surgical cure. It is anticipated that this data analysis will show that the current number of Indian ophthalmologists is insufficient and more support through the NGOs is required to maintain the current rate of cataract surgical cure. If the population in India continues to grow as expected over the next 10 years, it is likely there will need to be an increase in trained ophthalmologists as well as NGO involvement in order to sustain, and hopefully reduce, rates of cataract-caused blindness, a preventable negative outcome.

Staples High School

Teacher: Amy Parent

Project # 129

Leao, Isabella

Assessing the Effect of Simvastatins on BT20 cells, a cell line derived from Triple Negative Breast Cancer, that are exposed to environmental levels of BPA

Research Proposal, Health & Medical

Bisphenol A (BPA) is a hazardous chemical that affects women with Triple Negative Breast Cancer (TNBC). Recent studies have shown that patients with lung cancer, Pancreatic Ductal Adenocarcinoma, and Hepatocellular carcinoma taking statins to lower cholesterol had longer survival times. While studies have shown that statins can improve cancer patient survival, this project will test the effect of statins on the BT20 cell line derived from TNBC that are also exposed to BPA. Since BPA is an unavoidable environmental chemical, adding it to the cell line provides a realistic result. BT20 cells will be exposed to a range of 0-100nM of BPA and effects will be measured by the physical changes and the proliferative index. Then, the cells will be exposed to 30mg of simvastatin and evaluated for physical changes and proliferative index. BT20 cells not previously exposed to BPA will be used as a control. It is hypothesized that BPA will increase the proliferative index. Furthermore, it is expected that the addition of statins will lower the proliferation index of the cell line. This study suggests that along with other types of cancers, simvastatin will benefit breast cancer patients in decreasing their mortality rate. Statins are low costing drugs with few side effects, making them a good and effective treatment for those suffering from breast cancer.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 130

Lee, Ian

Designing More Biodegradable Packaging Material using Mycelium

Research Proposal, Environmental

Mycelium can also be used for packaging materials. Packaging can be costly and harmful to the environment. Plastic and similar packaging materials are not very biodegradable which leads to increased landfills. The purpose of this project is to design a more biodegradable packaging material using mycelium. The criteria of this project are to create packaging material at home with a loose mixture that can successfully protect objects it encases and for the material to be biodegradable while still keeping costs at a low, around 100 dollars or less. To design and develop the packaging, oyster mushroom spawn is used to grow the mycelium while being cost-efficient. The method to create the packaging first involves getting molds in the shape of the packaging. The mold was placed in a sanitized area and the process will be repeated until the desired amount of packaging is created. The packaging was then placed in a box encasing an object. The box was dropped from various heights such as three feet, five feet, and seven feet in order to test the durability and strength of the packaging material. The data analysis technique involves determining if the object encased in the packaging is damaged and signs of the sample contained crumbling and breaking to determine the biodegradability of the packaging material. With a strong, inexpensive, and biodegradable packaging material, future packaging will be more cost-effective and beneficial for the environment. Mycelium is a material with lots of potentials.

Amity High School

Teacher: Catherine Piscitelli

Project # 131

Lee, Youlmin

Determining the Most Effective Weekly Developmental Stage of Oenanthe Javanica to Filter Methyl Red Dye

Research Proposal, Environmental

The process of fabric dyeing causes water to be polluted with dye and is harmful to aquatic plants and animals due to the decrease in oxygen and sunlight in developing countries. Azo dyes are a type of dye that is difficult to biodegrade and includes the subcategory of methyl red dye. Possible solutions are phytoremediation with fungi, algae, and yeasts where high cellulose organisms filter the water from toxic chemicals like azo dyes used in fabric dyeing. It has been shown that *Oenanthe javanica* (water dropwort) can filter out TSS from water using a rock-plant filter. The purpose of this proposal is to determine the most effective age of *Oenanthe javanica* grown outside of dye water to filter out the azo dye. The hypothesis is that a stem node of *Oenanthe Javanica* grown for three weeks outside of dye-water will be the most effective at filtering dye-water because it puts the most amount of energy into producing its roots. Grown stem nodes will be grown in water for different amounts of time and then placed in dye water for one week. After one week cotton will be placed in the filtered dye water and compared to the control which will be the dye water alone. The color will be measured by a color detector app to obtain the hex-code of the dyed fabric. Determining the effect of the age of water dropwort on its filtering ability can inform the textile industry to reduce the pollution produced in developing nations.

Amity High School

Teacher: Nicholas Shamp

Project # 132

Lehman, Makenzie

How Does Time Affect Deoxyribonucleic Acid in Latent Fingerprints Found on Semi-Porous Surfaces?

Research Proposal, Physical Science

One common kind of evidence in forensic science is DNA, whether it be from hair, sweat (Yudianto & Kusuma, 2006), fingerprints (Oorschot & Jones, 1997), or other bodily products. In this experiment, DNA extracted from latent fingerprints on semi-porous surfaces will be used to determine what effect time has on DNA degradation. Latent fingerprints are produced by someone touching a surface and leaving behind an impression of skin cells and sweat that is invisible to the naked eye. In this experiment, three individuals will be asked to provide 5 fingerprints (corresponding to 1 day, 2 days, 1 week, 2 weeks, & 1 month). At each time checkpoint, the fingerprints will be swabbed, isolated from the swab, run through Polymerase Chain Reaction, isolated from PCR products, and put through Agarose gel electrophoresis to be analyzed. The data collected will be imaging of Agarose gel electrophoresis products. The statistical analysis procedures of standard deviation, standard error, t-score, and degrees of freedom will be used to show statistical significance of time affecting DNA and by how much it degrades over time. The fingerprints in this experiment are controlled, purposefully placed on previously-cleaned glass slides, and are left undisturbed in a room-temperature climate; for crime-scene analysis, latent fingerprint DNA is more likely to be degraded. This experiment should be viewed as baseline research, as future researchers may use this data in comparison to non-controlled prints, different environments, different ways to collect DNA in latent fingerprints, and different kinds of evidence containing DNA.

Weston High School

Teacher: Stacey Greenberg

Project # 133

Levine, Emma

The Influence of Allergies on Sinus Infections

Research Proposal, Health & Medical

Chronic Rhinosinusitis, or CRS, is a disease that affects millions of people across the world in continents such as North America, Europe, and Asia. The disease causes inflammation and swelling in the nose and it can be divided into two categories: with polyps (CRSwNP) and without (CRSSNP). Nasal polyps can be especially harmful to patients due to the fact that they cause an inflammatory response in the nose. Pathogens for CRS have been researched, but few studies have gone into depth about how specific allergens influence the development of CRS and nasal polyps. One specific allergen, cat allergens, is particularly potent because its light weight causes particles to remain in the air. The proposed research is going to find the correlation between the potent cat allergens and how they could affect the development of CRSwNP. Samples of cat allergen will be gathered and be added to a human sample such as mucosa. The effects will be studied and recorded in a laboratory or hospital. This experiment has not yet been conducted, so there are no results. However, the expected outcome is that possible inflammatory markers such as IL-2, IL-4, IL-12, and IL-22 could be spotted under a microscope. Further research will have to be conducted on how to identify these compounds.

Ridgefield High School

Teacher: Ryan Gleason

Project # 134

Lin, Joshua

Spill the Tea: Epigallocatechin-3-gallate (EGCG) May Provide Alternative Treatments for Numerous Illnesses

Research Proposal, Health & Medical

Project Title: Spill the Tea: Epigallocatechin-3-gallate (EGCG) May Provide Alternative Treatments for Numerous Illnesses
Problem Statement: Epigallocatechin-3-gallate, more commonly known as EGCG, is a naturally-occurring polyphenol most commonly found in green tea. It has been known to have anti-hypertensive, anti-atherosclerosis, anti-diabetes, anti-inflammatory, and antioxidant properties, which have proven useful in combating cancer, circulatory complications, and other harmful diseases.
Methods: In my research, I hope to find an effective treatment for certain non-infectious illnesses including Alzheimer's, various types of cancers, and circulatory disorders, balancing cost, time, efficacy, and side effects. I plan to do so by either isolating specific cells in controlled environments and investigating the results of different types of conventional treatment compared to EGCG, or conducting the same experiment through living organisms.
Implications of Project: Through these experiments, I hope to find a cost-effective, timely, and practical usage for EGCG, which can be applied to the world of pharmacology in treating and preventing certain diseases. Whether through primary or secondary treatment, I will prove that EGCG can be as effective, if not more, than conventional treatments while balancing cost, time, and other resources.
Conclusion: If the expected results prove accurate, then I hope to increase public awareness of EGCG and promote further research towards its application towards mainstream medicine.

Ridgefield High School

Teacher: Ryan Gleason

Project # 135

Liu, Maggie

Effects of Duckweed (*Lemna Minor*) and Roundleaf toothcup (*Rotala rotundifolia*) on Ortho-Phosphate Phytoremediation

Completed Project, Environmental

Phosphates are essential nutrients that are used for the formation of DNA, RNA, and cell functions. Due to this, they are utilized as fertilizers to promote plant growth. However, when they accumulate in lakes and rivers, it causes eutrophication which can harm wildlife and inhibit people from using the water source. The purpose of this project is to determine which common invasive plant (Duckweed [*Lemna minor*] and Roundleaf toothcup [*Rotala rotundifolia*]) is the most effective at removing phosphates from aquatic environments. I hypothesized that Roundleaf tooth will be the fastest at phosphate phytoremediation because they are grown attached to the bottom of lakes which allows them to have greater access to phosphates. The independent variable was the type of plants used and the dependent variable was the concentration of aquatic phosphates measured. The control group had 500 ml of water with 20 ppm of phosphates from Gordon's Liquid Lawn and Pasture Fertilizer 20-0-0. All control and experimental groups were kept in the same location to eliminate other factors. There were 6 trials for each plant group and 1 for the controls. Each trial had 500g of plant matter, 500ml of water with 20 ppm of phosphates, and a clear container. From there, I observed, recorded, and measured the amount of phosphates with Bartvation Phosphate 0-100 ppm Strip Tests two times a week for a month. Data trends thus far show that Duckweed has a higher phosphate phytoremediation rate than Roundleaf toothcup. By determining the most effective plant at removing phosphates, they can be used to bioremediate aquatic environments that are currently suffering from eutrophication.

Amity High School

Teacher: Catherine Piscitelli

Project # 136

Lowder, Bridget

Designing a Pill Dispenser to Eliminate Medication Errors, Overdoses, and Noncompliance

Research Proposal, Physical Science

In recent years, medication errors, overdoses, and noncompliance have become increasingly common issues in the healthcare industry. The FDA receives over 100,000 U.S. reports related to suspected medication errors annually and nearly 841,000 Americans have died since 1999 due to a drug overdose. Additionally, about 30% to 50% of adults are noncompliant with taking long-term medications as prescribed. The purpose of this project is to develop a new dispensing method utilizing tape and reel technology to eliminate medication errors, overdoses, and noncompliance. In this project the electronic components would be replaced by pills but the tape and reel technology would be used for the same purpose (to eliminate errors). The criteria for this project are that it needs to be better than the current system, capable of dispensing on a schedule, and able to alert patients when necessary. One possible solution will be to create multiple prototypes of a medication dispenser and determine the most effective design. Several container prototypes and dispensing mechanisms will be built and tested to determine the range of medication sizes and quantities that a container can accommodate. Afterwards, a breadboard prototype will be created and tested to determine the feasibility of storing prescription information, signalling, etc. The final prototype will be compared to current methods to see if the proposed solution is more reliable and effective. If successful, this project could improve how retail pharmacies dispense medications to patients through the usage of this novel device and potentially reduce harm/save lives.

Amity High School

Teacher: Catherine Piscitelli

Project # 137

Luo, Annabelle

Enzymatic pre-treatment of polyethylene plastic in the production of isobutanol in engineered *Ralstonia eutropha*

Research Proposal, Environmental

Plastic is a huge environmental concern with 75.6% of US plastic waste being disposed of in landfills in 2018. The bacteria *Ralstonia eutropha* (*R. eutropha*) has been engineered to synthesize energy rich alcohol biofuels from various carbon sources including plastics degradation products. However, viability of polyethylene (PE) as a nutrient has not been optimized or fully elucidated. Enzymatic pre-treatment of PE will be explored. *R. eutropha* will be cultured with PE film and PE degrading enzymes (PEDE): laccase, manganese-dependent peroxidase, and lignin peroxidase. *R. eutropha* will be pre-treated with varying concentrations and combinations of PEDE to determine the optimal approach for isobutanol production. Alcohol production will be measured by gas chromatography to show that the bacteria is capable of producing isobutanol with plastic as the sole carbon source. Plastic mass loss will be measured in grams to determine the amount of plastic nutrients degraded by PEDE. Additionally, PE film will be inspected under a light microscope before and after the experiment to qualitatively examine surface degradation. All PEDE are expected to yield signs of PE degradation to fatty acids. These fatty acids can enter beta-oxidation and produce Acetyl-CoA which can be modified in engineered *R. eutropha* to produce isobutanol. Manganese peroxidase is expected to have the most activity because in fungi grown on LDPE (low-density PE) film, it was the most abundant of these PEDE (Ameen, 2015, 134). If successful, this pre-treatment would supply an alternative fuel source to gasoline and a method to dispose of plastic.

Staples High School

Teacher: Amy Parent

Project # 138

Martin, Gabriel

Effectiveness of Fluoride in Drinking Water

Research Proposal, Health & Medical

Abstract: Objective: To determine the effect of the fluoride content put in city water on cavity prevention vs well water (no fluoride). Throughout decades of research, fluoride has been proven effective in the fight of cavities due to its anti-decaying properties. Over time fluoride has been introduced into water supplies for this sole reason, which now takes part in over 73% of the United State's population receiving water fortified with fluoride. Methodology: By sending a survey to distinct populations, those who drink city water fortified with fluoride, those who drink filtered well water, and lastly those who primarily drink from bottled water. I am still developing potential questions to have a more realistic research project, Expected Results: After analyzing the survey, the expected results are to see a beneficial correlation between the addition of fluoride and oral health. Conclusion: If the expected results proves accurate, then statistical significance between the addition of fluoride in different water can be determined strong and true.

Ridgefield High School

Teacher: Ryan Gleason

Project # 139

Mathew, Daniel

Creating a Module to Forecasting how NBA Players will Perform after an Anterior Cruciate Ligament Injury Based on Recovery Time

Research Proposal, Health & Medical

NBA injury rates remain high despite improvements in prevention. After major injuries, difficulties are deciding when the player should return to action. A player typically returns based on their performance in practice, readiness, and staff approval. While coaches have a rough outline of the expected return time, they don't know what to expect from their players. In playoff games, this is crucial, as a coach wants to engage their player as soon as possible. With a statistical method to predict their performance, coaches can make an informed decision about the players' projected performance before playing them. The purpose of this proposal is to create an algorithm to forecast an NBA player's performance after an anterior cruciate ligament (ACL) injury. The data needed for this project will be taken from publicly available websites for the years 2010-2018. The algorithm will measure performance through changes in stats like points per game (PPG), true shooting percentage (TS), game score, the amount of time it takes a player to return from injury, etc. These statistics will measure how effective a player is on return in comparison to before the injury. The average statistics for a player returning from an ACL injury will be recorded every three days from the earliest to the latest return dates. These intervals show measurements for how players perform after recovering. The result of the proposal will be a module that shows coaches how their players will perform after an ACL injury based on their return date.

Amity High School

Teacher: Nicholas Shamp

Project # 140

May, Katherine

A Search for Habitable Exoplanets: Using Spectroscopy to Identify Simultaneous Methane and Carbon Dioxide Signatures in Exoplanet Atmospheres

Research Proposal, Physical Science

In the search for life on exoplanets, current researchers use oxygen signatures and the “habitable zone” (HZ) as indicators of potential habitability. However, new research has shown that simultaneous traces of methane and carbon dioxide within exoplanet atmospheres better mirror Earth’s atmosphere when life first formed. Yet, this theory has not been adequately tested. This project will detect the presence of methane and carbon dioxide in exoplanet atmospheres within the HZ. It is hypothesized that this approach will uncover more likely candidates for potential habitability. To detect signatures of atmospheric methane and carbon dioxide, spectroscopy will be performed using the Very Large Telescope. As an exoplanet transits its star, its atmosphere will absorb certain wavelengths of light, while allowing others to pass through. Methane and carbon dioxide will absorb specific wavelengths and their presence will be revealed with a comparison of the atmosphere’s normal wavelength absorption with the transit absorption. It is believed that exoplanets with potential for life will show simultaneous signatures of methane and carbon dioxide. It is believed that these signatures will be discovered within the HZ, indicating increased potential for life. This study will create an opportunity to utilize a new approach to explore exoplanet atmospheres for traces of life and will offer new candidates for habitability. If the hypothesis is supported, further research can be conducted on these candidates and they can potentially unveil certain atmospheric properties that could be vital to the understanding of life on other planets and Earth’s own atmospheric evolution.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 141

McGrath, Regan

Attraction of the Invasive Asian Jumping Worm (*Amyntas agrestis*) Through Differing Wavelengths of Light

Research Proposal, Behavioral

The invasive Asian Jumping Worm, or Crazy Snake Worm, can consume more organic matter in less time than other worm species due to their relatively large size. This fast consumption results in nutrient overload, which can injure plants or cause runoff into streams and lakes. Worm activity also damages mycorrhizae (hair thin threads of fungi that weave together the roots of plants) by breaking apart the substance, thus damaging or killing plants that are dependent on it. This research will attempt to determine whether incandescent, ultraviolet, or a certain wavelength of visible light is most effective for attracting a larger amount of Asian Jumping Worms. Worms gathered from Connecticut soil will be placed in a dark room in containers with the same soil they were taken from. Light placed at one end of the container will either act as an attractant, deterrent, or it will have no significant impact on their behavior. Expected findings are for ultraviolet and blue or green visible light to be the most effective for attracting the worms. Since the incandescent bulbs produce heat and this species is nocturnal, this particular light might deter the species. The implications of this research are that by knowing which wavelengths of light are best for attracting the worms, they can be more easily extracted from the soil. This could improve soil conditions, promote plant growth, and solve the imperative issue this invasive species is causing in the Northeast.

Ridgefield High School

Teacher: Patrick Hughes

Project # 142

Medeiros, Malin

Immunosenescence in late relapse of acute myeloid leukemia (AML): correlation with clonal evolution or therapy-related relapse?

Research Proposal, Health & Medical

Immunosenescence, defined as the progressive alterations in the immune system associated with age, is a leading cause of late relapse in acute myeloid leukemia (AML). It was identified that 1-3% of patients who relapsed after 5 years had late relapse. If patients with AML have late relapse due to immunosenescence is it related to therapy or clonal evolution-related relapse? Whole-exome sequencing will be performed in bone marrow samples of 30 patients with late relapse (15 patients being under the age of 17 and 15 being older than 75). Data will be gathered using the SPSS software to perform advanced statistical analysis and reveal mutations discovered in each patient. This comparison will determine whether immunosenescence has an effect on the cause of late relapse and where it is a result of therapy-related or clonal evolution. It is expected that the older age group will have late relapse due to immunosenescence because of their weakened immune systems and it is probable that this will be caused by clonal evolution because of the clonal hematopoiesis that occurred prior to relapse. This study may be used for future research with AML in older patients with a weakened immune system in order to prevent late relapse. The potential discovery of clonal evolution in late relapse due to clonal hematopoiesis will help scientists to understand and uncover prevention for late relapse.

Darien High School

Teacher: David Lewis

Project # 143

Meier, Lucas

Function and Formation of External Structures of Termite Nests

Research Proposal, Environmental

The termite nest is one of the architectural wonders of the living world, built by the collective action of workers in a colony from the indirect coordination of pheromones. Each nest has several characteristic structures that allow for efficient ventilation, cooling, and connections with the outside of the nest. We plan to externally examine excavated nests and use X-ray tomography to quantify and determine the purpose of the external nest structures of the African termite *Apicotermes lamani*, which we expect consists of a series of regularly spaced perforations across the outside walls of the nest that serve as a ventilation system, facilitating gas exchange between the inside and outside of the nest. To understand how these external structures are built and arranged, we plan to formulate a minimal model of three hydrodynamic fields--mud, termites, and pheromones--linking environmental physics to collective building behavior using simple local rules based on experimental observations. We expect to find that these regularly spaced perforations will emerge from these governing equations, with statistics of the model consistent with observations of *Apicotermes lamani* nests. We expect this study to demonstrate how a local self-reinforcing biotectonic scheme is capable of generating an architecture that is adaptable and functional, and likely to be similar to the architecture produced by actual colonies.

Darien High School

Teacher: Guy Pratt

Project # 144

Mercado, Max

Impact of Claw Number on Grip Strength of an Asteroid Landing Apparatus

Research Proposal, Physical Science

Research on asteroids is needed because it's essential for developing asteroid deflection systems which are used to protect the planet if an asteroid is projected to hit earth. There exist other asteroid landing apparatus(ALA), however, there's no ALA that has a high reliability in landing for prolonged research. The bounce landing method is unreliable due to the extreme low gravity and regolith surface of asteroids and the Touch-And-Go(TAG) method is for one-time use only. In order to complete successful in-depth research, it's imperative to have a reliable landing method and the claw-based asteroid landing apparatus(CBALA) was recently proposed by Wang Yongbin (2021) as a new and reliable method for landing. The objective of the study is to assess whether a CBALA is universally reliable for all asteroid probes. CBALAs consisting of 3, 8, 16[current construct], and 24 claws will be tested on olivine and asphalt asteroid models. Grip strength will be measured in Newtons via a force gauge. It's hypothesized that the CBALA with 24 claws will have the largest grip strength exerted on both asteroid models because more claws correlates to increased points of contact thus stronger attachment. A CBALA may substantially increase the reliability of asteroid probe landing missions and support an optimized claw-based landing apparatus as the primary method to land on asteroids in future missions. Yongbin, W., et al. (2021). International Journal of Aerospace Engineering, 2021.

Staples High School

Teacher: Amy Parent

Project # 145

Messina, Sophia

The Effect of the Mass Ratio of Carbon-Rich Yard Waste to Nitrogen-Rich Yard Waste on the Decomposition Rate and Quality of Compost

Research Proposal, Environmental

Approximately one quarter of waste in landfills is made of compostable materials and therefore capable of being removed from the waste stream and reused. Carbon, nitrogen, proper moisture level, sufficient aeration, and heat are all key factors to composting successfully. An excess of nitrogen causes liquefaction and an excess of carbon results in a long decomposition time. This proposal aims to investigate which ratio of carbon-rich yard waste (dead leaves) to nitrogen-rich yard waste (grass clippings) results in the quickest decomposition while producing usable compost. The hypothesis is that a 1:1 mass ratio of dead leaves to grass clippings in a compost sample will decrease in volume and produce usable compost more than other ratios because the C:N ratio will provide an optimal environment for microorganisms to thrive. The location of the composting buckets, the ambient temperature, and the amount of time the materials in each bucket are mixed or “turned” will be the same for all five samples. The starting mass of material in all five buckets will be equivalent, containing a different mass ratio of chopped up dead leaves to grass (1:0, 3:1, 1:1, 1:3, 0:1). Each week, the bucket volume, mass, and temperature will be measured and then turned over for an 8 week time period. The decomposition rate will be calculated and the final volume of materials will be measured at the end of the two-month time period to determine which test group was most successful.

Amity High School

Teacher: Nicholas Shamp

Project # 146

Miranda, Bernardo

The regulation of Hsp70 on Fibrillary Tangle oligomerization and toxicity through the interference of low molecular weight oligomers

Research Proposal, Health & Medical

Alzheimer's disease (AD) is a progressive neurodegenerative disorder leading to dementia caused by neuronal dysfunction and death. The most significant symptoms of AD are observed at later stages of the disease when interventions are most likely too late to ameliorate the condition. A vaguely explored aspect of Alzheimer's is the tau buildup in the neurons. Previous research with the scope on the relationship between heat shock proteins and tau proteins' microtubule relations have shown that Hsp70 and Hsp90 interact with tau proteins, but tau oligomerization has been very vaguely researched. It is a common theory that peptide-induced aggregates that are neurotoxic are the main cause of cell death in AD. Achieving a deeper understanding of the molecular and cellular mechanisms that allow such plaques and tangles to form is vital to the development of therapies for Alzheimer's. As shown in other research experiments, Hsp70 prevents the oligomerization of amyloid β , the protein that forms plaques. It is possible to relate this to tau, hypothesizing that Hsp70, or a similar protein, could disrupt oligomerization of fibrillar tangles, reducing neurotoxicity and preventing apoptosis. It is unknown whether Hsp70 or similar heat shock proteins coexist with tau in a common environment. We want to test how Hsp70 will affect Tau in many conditions and environments, and if the tau buildup process relates to amyloid oligomerization. We expect Hsp70 to interact similarly to tau as it did amyloid-Hsp70 will interact with tau and either end oligomerization or increase solubility of post-oligomerized neurofibrillary tangles.

Darien High School

Teacher: Guy Pratt

Project # 147

Murphy, Robin

Comparing Novices and Native Speakers' Tonal Pronunciations in Mandarin Chinese to Improve Artificial Intelligent Voice Recognition for Language Learning

Research Proposal, Behavioral

Current technology for learning languages focuses more on literacy rather than verbal communication skills; voice recognition softwares experience issues of accuracy and misinterpretation among variations of dialects and pronunciation. Therefore, this project seeks to compare speech-to-text data taken from Mandarin learners and native speakers in order to enhance lingual learning methods. My proposed solution will investigate the accuracy of existing voice recognition systems and improve our understanding of this technology. I will create an application to record given sentences spoken by a group of 10 beginners learning Mandarin and 10 native speakers. Then, I will analyze the character recognition data for accuracy. These recordings will be stored in a database, which will be used as training data for the app's voice recognition. Additionally, my app will have a comments component for the participants to provide feedback on the app's performance. The two group's data will provide statistics displaying how well speech recognition systems will operate with variations of Chinese tone, fluency, and dialect. The comment feature will also provide participants' ratings, assessing the app's proficiency and efficacy in aiding language learners. This application will help students' advancements in learning Mandarin dialogue, as well as other languages. The app's statistics will also contribute to our understanding of voice recognition systems' limitations and potential revisions.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 148

Murphy, Ellis

Meta-Assessment of Ethyl Acetate and Chlorobenzene as Solvents in Perovskite Solar Cells

Research Proposal, Physical Science

The problem that this proposal seeks to answer is if ethyl acetate, a green and non-volatile solvent, is able to consistently match performance of chlorobenzene in perovskite solar cells. With the effects of climate change threatening to pose irreversible damage to the Earth, replacing carbon-based fuels with renewable energies is of the utmost importance. It is hypothesized that due to ethyl acetate's similar properties and function to chlorobenzene as a solvent/antisolvent in perovskite solar cells, studies comparing the two should yield similar results. Currently, researchers are seeking methods of making the entire photovoltaic cell process green, including manufacturing. As a result, the two materials as well as other green and toxicological solvents have been compared frequently. This project proposes a meta-review method of comparing available data and performing statistical analysis to determine trends in efficacy as well as determine the difference in performance between the two solvents. Data will be collected from published material in databases such as Google Scholar. Chi-square tests, tendencies of data, and other statistical tests will be employed to determine the viability of data. It is anticipated that from available data, ethyl acetate will match results to those of chlorobenzene-treated photovoltaic cells. This outcome would further affirm the viability of green solvents as replacements of toxicological solvents, which could be relevant to other engineering processes. The total costs of a process must be weighed against each other in order to maximize the efficiency of said process, which is especially important in the photovoltaic industry.

Darien High School

Teacher: Christine Leventhal

Project # 149

Nafde, Ayush

The Relationship Between the e4 Allele and Cumulative Risk of Vascular Dementia

Research Proposal, Health & Medical

Dementia is a general term for any impairment to memory or decision making skills that interferes with everyday activities. Alzheimer's Disease causes 60-80% of dementia cases. Vascular dementia, which results from inadequate blood supply to brain tissue, accounts for another 15-20%. The e4 allele of the APOE gene is known to increase the risk of developing Alzheimer's Disease substantially, but it is unclear if it is related to vascular dementia. It is hypothesized that the presence of at least one e4 allele will be associated with a higher cumulative risk for vascular dementia. This observational study will use a sample of adult volunteers. Demographic data, clinical information, and genomic testing will be obtained. MRI imaging will be used to determine the presence of vascular dementia. Genotyping using restriction fragment length polymorphism and amplification of codons 112 and 158, the origin of the polymorphism, will determine the specific allele of APOE. The participants will be followed up for a period of ten years. Kaplan-Meier curves and survival analysis using Cox proportional hazard regression will be used to determine the cumulative risk of vascular dementia among patients with and without at least one e4 allele. It is anticipated that the cumulative risk of vascular dementia will be greater in volunteers with at least one e4 allele than those without it. If the hypothesis is supported, it suggests the need for more rigorous proactive measures to prevent vascular dementia in patients carrying e4 alleles.

Darien High School

Teacher: Guy Pratt

Project # 150

Napolitano, Andie

Creating and Testing an Application to Promote the Development and Continuity of Sustainable Habits

Research Proposal, Behavioral

Sustainable habits have the potential to combat the effects of climate change, however, many people are unmotivated to act sustainably. Research has shown sustainability-based smartphone apps have the potential to improve climate change communication and create a community in which people influence each other to develop sustainable habits. Many studies have also found a correlation between positive feedback and increased motivation. The purpose of this application is to encourage users to develop sustainable habits using the peer pressure generated by an online community, and the positive feedback of a point-reward system. An application development framework was utilized to create this application. After the application was created, it was tested by willing participants. Participants estimated the number of times they engage in each of four recommended sustainable habits for two days before using the application and recorded this information on a pre-experience survey within the application. Throughout the next two days, participants tracked and recorded each time they complete a task on the application. They received a certain number of points for completing each task. Each participant then completed a post-experience survey within the application. The number of times each participant completed each task before and after using the application, as well as their motivation to act sustainably was compared. Implications of this application include the development of sustainable habits that help combat the effects of climate change, and research as to whether online media communication aids climate change mitigation.

Amity High School

Teacher: Catherine Piscitelli

Project # 151

Narang, Anusha

Use of machine learning to predict optimal growth conditions for crops

Research Proposal, Environmental

With the world's population expected to reach 9.7 billion by 2050, the ability to maximize crop yield has become more important to agriculture. Fertilizer adds nutrients to soil which can enhance crop yield. One of these nutrients is Nitrogen and an over application can lead to harmful environmental effects such as run off into water which can cause eutrophication. It is important to optimize fertilizer application and prevent over or under application. In addition, agriculture is one of the greatest consumers of freshwater. It is expected that the population's need for water will increase anywhere from 25-40% in the future and this water may have to be reallocated from agriculture. In an attempt to solve these problems this study proposes the use of machine learning to predict optimal fertilizer and water usage. To do this the program will be given data from pictures of the crops as well as data from soil. The program will be able to track the plants growth, pH of the soil, mixture levels, and weather conditions to make recommendations. The program's recommendations will then be used to grow a test batch of crops which will be compared to a batch of crops grown with standard techniques. The algorithm's efficiency will be evaluated off the water and fertilizer saved from this technique and the height and mass of the test crops. This will evaluate the effectiveness of smart farming techniques for sustainable agriculture.

Darien High School

Teacher: Guy Pratt

Project # 152

Nemec, Kate

Using Nanoneedle Patches to Explore the Interaction Between Biomolecules, Disrupted In Renal Carcinoma 3 and 6 Hydroxy Aminopurine, and Melanoma Proliferative Indexes

Research Proposal, Health & Medical

Using Nanoneedle Patches to Explore the Interaction Between Biomolecules, Disrupted In Renal Carcinoma 3 and 6 Hydroxy Aminopurine, and Melanoma Proliferative Indexes
Melanoma cancer is metastatic cancer in which the victims of melanoma suffer from harsh treatment plans, including surgery, chemotherapy, or radiotherapy, which leave lingering effects like “mouth sores [...] increased risk of infection [...] and easy bruising” (American Cancer Society). The purpose of this study is to analyze raw data that will postulate a less invasive approach to suppressing melanoma tumors. This comparative data analysis study investigates two biomolecules—Disrupted In Renal Carcinoma 3 (DIRC3) and 6 Hydroxy Aminopurine (6-HAP)—and their ability to suppress melanoma tumors through a minimally invasive drug vehicle: a nanoneedle patch. The proliferative index of tumors will be measured over four weeks, as the preliminary dosage increments take two weeks to administer, and observations will be made in the ensuing weeks. Raw data collected in contacted labs will be analyzed to determine a correlation between the reduction in the tumor’s size and the rate of blood infiltration by the nanoneedle patches. It is expected that DIRC3 and 6-HAP will work mutually in the topical fusion treatment to decrease the size of melanomas by over 60% at varying stages of skin cancer and with different doses and surface areas of the patches. The patient will not suffer from long-term effects from treatment. The procedure, however, does create an enigma, as scientists continue to study the newly discovered molecules' capacities for destruction or preservation of cellular proliferation in the human epidermis and lymph nodes. The utilization of modern, medically engineered technology coupled with biological cancer suppressants in this study will exhibit the future of clinical treatment of cancers as scientists learn to attack metastasizing cancers within their targeted proliferative index.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 153

Nomani, Adam

Passive Thermal Energy Storage for Air Conditioning Systems Utilizing Phase Change Material

Completed Project, Physical Science

Around 750 billion kWh of energy is used to provide cooling in commercial buildings annually. This energy consumption is also expected to increase approximately ten-fold by the year 2050. Air conditioning (AC) is something that is in very high demand and because it consumes a large amount of energy, this can potentially harm the environment. In addition to the extreme energy consumption of AC units, they are also mainly utilized during the time of day when energy costs the most during peak hours of the day. To help reduce the energy consumption and cost usage of AC units, we designed a heating, ventilation, and air condition (HVAC) system that can passively provide cooling. The main component of our system is phase change material (PCM), which releases and absorbs energy at its phase transitions to provide heating and cooling. This provides passive cooling as the PCM can be frozen and when it melts it absorbs heat from its surroundings, producing cold air. We constructed a prototype to hold the PCM and tested it in HVAC systems at three different fan settings: low, medium, and high speed. Low speed produced the most promising results, as it provided cooling for approximately 104 minutes, while medium and high speeds only provided cooling for 80 and 54 minutes, respectively. This system can be utilized to reduce energy consumption of AC users, which can additionally help reduce the cost usage of AC units. Moreover, less energy consumption overall will produce fewer carbon emissions, thereby mitigating the climate crisis.

King School

Teacher: Victoria Schulman

Project # 154

Olvany, Steven

A Comparison of Synthetic Fuels

Research Proposal, Environmental

A Comparison of Synthetic Fuels On a large scale, producing gasoline synthetically would provide a carbon-neutral transportation solution with minimal change. Additionally, it would create a fuel source that does not rely on fossil fuels, thus eliminating the concern for the nonrenewable resource to run low. This study will compare the three leading synthetic fuels: fuel from atmospheric carbon, fuel from waste, and fuel from biomass. The study will aim to determine which of the following synthetic fuels is most practical for widespread use. The focus of the study will further analyze the cost, availability, feasibility, and effect on the environment of each type of synthetic fuel. The study will utilize a multi-criteria decision-making method in order to pay regard to all the prominent factors as well as produce a result for which synthetic fuel is the best suited for large-scale applications. I predict fuel from atmospheric carbon dioxide will emerge as the most suitable candidate for widespread use. Utilizing the conclusions of this research, fuel-producing companies will be exposed to alternate ways of producing fuels and evidently learn the most practical method to do so. It is imperative that new methods are put into effect concerning the fuel and transportation sector. Climate change is approaching the point of no return and fossil fuel reserves are depleting, leading to a pressing issue in need of considerable attention.

Darien High School

Teacher: David Lewis

Project # 155

Orr, Josephine

What's in our water? Quantifying and Analyzing Microplastics in Coastal Ecosystems of Greenwich

Research Proposal, Environmental

Microplastics are less than 5mm, which makes them easily mistaken by animals for food, which are then consumed by larger animals. They can end up harming nearly every animal species in the ocean, and in turn, even humans. This project aims to quantify the microplastics in marine ecosystems of coastal Greenwich, Connecticut, and analyze the data to identify patterns in the distribution. Samples of surface water from varying coastal areas in Greenwich and data on the conditions such as weather and tide will be collected, and the water will be filtered through a suction device or strainer. Then, the microplastics that are found in each water sample will be analyzed by using a microscope and the data will be interpreted with regard to the environmental factors. It is expected that the number of microplastics found in each area will vary, with the high traffic location having a higher amount (Greenwich Harbor). The prediction is that other patterns with regards to the environment of each area will be discovered, which will be helpful with regards to future research. This study will demonstrate the correlation between certain conditions and high amounts of microplastics, or a specific type of microplastic, and contribute to the lack of data in Greenwich. The hope is that this information will impact future studies, and possibly change the mindset of the community, in order to prevent further accumulation of microplastics in our local environment.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 156

Oslowiecki, Sabrina

Designing an App to Track and Warn Users About Potentially Dangerous Animals Via User Submission

Research Proposal, Environmental

In areas with many people there are wild animals that could pose a physical threat to residents and pets. In Connecticut alone, there are many examples, like bears, wolves, and lynxes. Some existing solutions for tracking wild animals are camera traps and tracking collars, but these are used mainly for research, and are not readily accessible to the public. The purpose of this proposal is to design an app that can track and warn people about dangerous animals via user submission. It must be location specific, allow for user submission, notify users when an animal is identified nearby, and the location of the user must be changeable for when they move/travel. When reporting an animal, users will input their location, upload an anonymous report including the species whenever they see a potentially dangerous animal. Phase one is coding the general app, including user profile, reporting features, and basic location settings, phase two will focus on improving the app by adding options to upload photos and learn about species in the selected area for more accurate identifications, and phase three is improving aesthetics and GPS features. This proposal has value because it will help users who fear wild animals and provide protection while camping or letting pets out alone and it fills the need for a dangerous animal community warning system.

Amity High School

Teacher: Nicholas Shamp

Project # 157

Piccuillo, Andrew

Identifying Genetic Pathways for Hemophilia

Research Proposal, Health & Medical

Hemophilia is a rare genetic disorder caused by the absence of necessary clotting factors in blood. There are two main types of Hemophilia; Hemophilia A, (lack of clotting factor VIII), and Hemophilia B, (lack of factor IX). The standard treatment is factor injections directly into your blood. Treatment limitations are that it is based on an inaccurate diagnosis, requires recurrent dosing which produces fluctuations in factor levels, factor is hard to access, store, and maintain because of high cost and the fact that it expires in six months and must be refrigerated. Testing for Hemophilia involves screening for protein levels of factors VIII and IX to determine which type of Hemophilia and its severity. This method is limited because it doesn't identify the primary molecular target underlying the clotting factor deficiency. The project intent is to establish a sequencing-based assay to screen patient blood samples for changes in specific genes which code for many components of the platelet clotting cascade, including factors VIII and IX. We will sequence the panel of hemophilia-related genes from DNA from affected individuals and unaffected controls and compare it to the "normal" human genome to determine which genetic changes are specific to affected individuals. We will predict the consequences of genetic changes identified uniquely in affected individuals through protein prediction algorithms to more reliably identify the genetic culprit of Hemophilia. This diagnostic method would provide more accurate information and potentially pave the way for personalized treatment options for patients with improved outcomes over the standard treatment.

Newtown High School

Teacher: Timothy DeJulio

Project # 158

Podila, Kavya

Examining the Relationship Between Persistent Beta Cells in Type 1 Diabetes and Location on Pancreas

Research Proposal, Health & Medical

Type 1 Diabetes (T1D) is characterized by autoimmune destruction of pancreatic beta cells. However, reports indicate persistence of beta cell mass and function in long-duration T1D cases. The cause of this preservation remains unclear. The purpose of this experiment is to determine if location is a cause for beta cell survival, to better understand why beta cells are able to survive. Slide images of the head, body, and tail of the pancreas from multiple, long-duration T1D donors will be accessed through online pancreatic donor networks such as Pancreatlas and nPOD. The slides will be analyzed for insulin-positive areas, which are an indicator of functioning beta cells, and the NIH's ImageJ program will be used to quantitate the area of the beta cells in each slide. The data will be evaluated to determine the relationship between persistence and region. The findings should reveal scattered insulin-positive regions through staining. Regions with the greatest area of insulin-positive islets will indicate the greatest presence of beta cells, while lower areas will indicate an insignificant presence of the cells. Based on location of regions with highest insulin-positivity, further analysis of factors such as disease duration and age of onset will be evaluated to determine if a correlation exists. This experiment will reveal where beta cells are most likely to survive within the pancreas in T1D. The results will provide insight into where to target long-term treatments of T1D to maintain optimal insulin secretion and improve understanding of conditions needed for beta cells to thrive.

Ridgefield High School

Teacher: Aine Kapell

Project # 159

Qin, Bo-Jun

The Influence of High Solar Wind Pressure on Martian Atmospheric Escape

Research Proposal, Physical Science

As scientists continue to explore whether Mars can support life, the study of the evolution of Mars's magnetic field and its impact on its escaping atmosphere has become more prevalent. Unlike Earth, Mars has regions of crustal magnetism rather than one global magnetic field. These local magnetic fields on Mars may cause more atmospheric loss than the absence of a magnetic field. This research will investigate the influence of high solar wind pressure on Martian regions with and without local magnetic fields. Data on solar wind pressure will be collected from the Solar Wind Ion Analyzer on the Mars Atmosphere and Volatile Evolution spacecraft. The rate of ion outflow from the Martian atmosphere will be measured in regions with a local magnetic field and regions without any magnetic field. Data will then be compared between rates during periods of high and mild solar wind pressure and rates in regions with and without magnetic fields. It is expected that there will be a higher rate of ion outflow in regions with crustal magnetic fields, because high solar wind pressure causes the formation of cusps where ions escape the atmosphere. A better understanding of Mars's crustal magnetic field will contribute to the investigation of how the loss of Mars's dynamo has resulted in its thin atmosphere today. The next steps of this research would be to further analyze the causes of atmospheric loss on Mars and how Earth may face the same fate as Mars.

Darien High School

Teacher: Christine Leventhal

Project # 160

Quayle, Emma

The Role of the Media: Fame as a Motivator for School Shootings

Research Proposal, Behavioral

Since 1970, 1,316 school shootings have occurred in the U.S. 2021 alone had 149 incidents of gunfire on school grounds, resulting in 32 deaths nationally. With the increased rate of school shootings comes widespread coverage in the news. Shooters are broadcast on TV and online media platforms such as Instagram and Twitter, gaining widespread attention. With such large and frequent coverage, is fame a motivator for school shootings? This study will investigate the relationship between media coverage and the frequency and fatality of school shootings events. Using a reference period of 24 months, events are examined by the amount of local and national media coverage they receive. In the reference period, how frequent the events are to each other is also examined to help determine if a pattern of when events occur surrounding the coverage of another event exists. I predict that more media coverage will result in more fatal and subsequent events, predicting that fame is a motivator of school shootings. I also expect that more national coverage will have a greater impact on the fatality and frequency of shootings. Further studies can apply this research beyond school shootings to serial killers or widespread mass shootings. Using the data collected, I will be able to help suggest how the media can broadcast shootings without glorifying the shooter.

Darien High School

Teacher: Guy Pratt

Project # 161

Raissi, Dariush

Testing the Effects of Different Types Light and Raw Phosphorus On Mugwort and Mung Beans to Find Optimal Growth

Research Proposal, Environmental

Three tactics used by agriculturalists to increase growth in plants are the use of grow lights, infrared light, and fertilizer on their plants. Grow lights send out a full spectrum of light, which speeds up photosynthesis while infrared light increases the space between the nodes in the plant. Raw Phosphorus® is an additive that promotes root growth. Both mugwort and mung beans grow at a fast rate. This project will investigate the most effective combination of phosphorus and light that will encourage plant growth the most. It is hypothesized that the combination of infrared light and phosphorus will have the greatest plant growth. The independent variables are the type of lamp and the addition of phosphorus. The dependent variables are plant height, leaf growth, stem width, and qualitative features. There will be 6 groups. The first will be the control, which will not be exposed to the effects of phosphorus or any lamps. Group two will only be exposed to infrared light. Group three will grow with a grow light. Group four will grow with Raw Phosphorus®. Group five will grow with a combination of the grow light and phosphorus. Group six will be a combination of infrared light and phosphorus. The plants will be measured every three days, for as long as time permits the experiment to continue. Raw phosphorus will be added once the plant grows to the height of 4cm. Data will be compared to determine any significant difference in plant development depending on treatment.

Amity High School

Teacher: Catherine Piscitelli

Project # 162

Raveis, Laci

The Effect of Ozone, Nitric Oxide, Pesticides, and Vitamin D on the Development of Alzheimer's Disease in Drosophila

Research Proposal, Behavioral

Alzheimer's disease has recently been declared as the sixth leading cause of death in the US, and arguably third in those 65 and older. Alzheimer's disease (AD) is commonly known as an incurable disease that eventually leads to death. This experiment seeks to identify specific environmental factors that may effect the development of AD. Ozone, Nitric Oxide, Pesticide, and Vitamin D are all factors with strong evidence of effecting AD. These environmental factors will be tested in Drosophila who have a disruption in their gene (APP, PSEN1, or PSEN2), and those with regular gene frequencies all from Bloomingdale Drosophila Center. Ozone levels will be tested through an ozone generator. The Vitamin D test will be conducted through an artificial sun lamp. Pesticide will be tested through a pesticide contact test. Nitric oxide is tested through a chemical reaction of copper and nitric acid that will be infused into the Drosophila chamber. The progression of AD will be tested by a Drosophila walking and flying test, in addition to a light microscopy observation of the dissected brains after death. Research studies suggest that all of the factors listed above advance the development of AD, therefore it is probable that the results of this experiment will yield similarly. It is predicted that the Drosophila subjected to the various tests will have less motor and sensory functions than those that were not. Furthermore, it is predicted that their brain will appear greatly effected as compared to a control group.

Greens Farm Academy

Teacher: Mathieu Freeman

Project # 163

Robison, Noah

The effect of suspended solids in water on the delinearization of plasmids by UV-C irradiation

Research Proposal, Environmental

Antibiotics combat bacterial infections, but over time some bacteria become resistant to antibiotics and can create infective 'superbugs' (O'Neill, 2016). Antibiotic resistant bacteria (ARB) spread antibiotic resistant genes (ARG) through plasmid transmission. It has been observed that suspended solids (SS) in water can assist bacterial growth, therefore, inducing ARG transmission. SS are found in all drinking water distribution systems (DWDS) and can be sites for ARG transmission. UV irradiation is currently used to disinfect water before consumption, but it is unknown whether the amount of SS can affect the efficiency of UV irradiation. In this study, the effect of SS on the efficiency of UV irradiation will be assessed. Varying amounts of the natural SS in samples of Saugatuck Reservoir water (SRW) will be produced via dilution with distilled water. SS samples (turbid water, clear water with no dilution, and three samples diluted at ratios of 1:1, 1:10, 1:100) will be seeded with the DNA plasmid pUC19. Samples will be irradiated for 1 hour (5 W, 365nm). DNA will be extracted and evaluated via gel electrophoresis to determine the extent of DNA linearization. It is anticipated that as the SS in SRW increases, the efficiency of UV irradiation decreases. The elimination of SS in DWDS could increase the efficiency of UV irradiation and eliminate chances for ARB infection from drinking water.

Staples High School

Teacher: Amy Parent

Project # 164

Rodgers, Vavi

Effects on Ecosystem from Invasive Insects Attacking Native Trees in the Hudson Valley

Research Proposal, Environmental

Project Title: Effects on Ecosystem from Invasive Insects Attacking Native Trees in the Hudson Valley
Problem Statement: Emerald Beetles, and other invasive insects are destroying the native trees in the northeast of the United states. It is unclear what the overall effects are on the ecosystem as a whole when such large trees die. Methods: I will survey different forest regions in the Hudson Valley and compare the flora and fauna in areas where Ash Trees are still living and where Ash Trees have died. This will include identifying plant and animal species that live on or beneath these large trees and observing the effects of the deaths of these trees. I will also need to consider the effects of the time since the tree has died and the population density of trees dying in each place. Results or Implications of Project Conclusion: The results of this project could assist in the development of solutions to limit the detrimental effects of invasive species. This could also potentially assist in keeping the environment strong or maintain good forest ecosystems for the wildlife and future generations. This could further assist with the effects of global warming as better forests would provide more oxygen to target the rising carbon dioxide levels. Loss of tree species could have an outsize effect on the survival of life on a regional and then global scale.

Ridgefield High School

Teacher: Ryan Gleason

Project # 165

Rubio, Maya

What are the effects of different color tattoo inks on the body?

Research Proposal, Health & Medical

When starting my research I had looked into others scientist findings that have done similar studies, It was found that China tattoo ink is severely toxic and can lead to diseases and infections which are life threatening. Once I start to research I would like to look into a certain tattoo ink brand and color so I can have a strong base for my research and then build of there once I have a general idea. When i have some data I will then start comparing the original data of one tattoo ink brand and color to others and see how the differentiate. As of right now i have found that these Metals found in tattoo inks that are not FDA or EPA approved are Bornium(Br), Silicon(Si), Sulfur(S), Chlorine(Cl), Calcium(Ca), Titanium(Ti), Chromium(Cr), Iron(Fe), Nickel(Ni), Copper(Cu), Zinc(Zn). These metals have been proven to be linked to skin cancer, hepatitis B and C, MRSA, Bacterial infections and much more.

Ridgefield High School

Teacher: Ryan Gleason

Project # 166

Salman, Shafay

Do ACL Injuries in Basketball players have better long-term clinical results after getting a BPTP autograft or HT autograft replacement after injury?

Research Proposal, Health & Medical

Does a patellar tendon (BPTP) autograft or a hamstring tendon (HT) autograft for an ACL tear provide superior long term results? The way this problem will be addressed is through a postoperative rehabilitation program comparing the HT autograft to the BPTB autograft. Each autograft group will be composed of ten basketball players between the ages of eighteen and thirty who have torn their ACL ligament, and will perform the same rehabilitation protocol for nine months. After, the results will be collected based on their leg symmetry index (LSI). The closer the knee is to providing a ninety-degree angle, the better the results will be, as LSI and leg hop strength (LHS) are directly proportional. The results should show superior clinical results in the BPTB autograft group due to there not being a second area of the body in pain, and there being no risk in a second surgery site. This absence of potential pain will allow the individuals in the BPTB autograft group to feel more comfortable going into the rehabilitation program versus the HT autograft group. Some potential implications in this study include the difference in the size of ACL tears, which can lead to different autograft sizes, and the difference in the time since the ACL tear, causing some individuals to be ahead of others in the recovery process before the rehabilitation program begins.

Darien High School

Teacher: Christine Leventhal

Project # 167

Sandhu, Gurshaan

How the intensity of an exercise affects cell-mediated immunity through the release of anti-inflammatory cytokines

Research Proposal, Health & Medical

Physical activity to a certain extent and intensity affects one's immune system both negatively and positively. Negatively, because many proteins or cytokines released can increase inflammation in certain parts of the body, but this is only for high-intensity exercise. However, for low intensity and medium intensity, it increases immunocompetence and is beneficial for the immune system. It can have a positive effect because the cytokines released would increase in the amount released, causing better health and the use of the immune system would become more efficient. What is not known is how the intensity of an exercise affects cell-mediated immunity through the release of anti-inflammatory cytokines. Having a better understanding of the effect of exercise on the immune system can result in more effective treatment options for patients and overall better health. Currently, medical engineers are experimenting with possible ways to improve cytokine releases in people that have deficiencies. To conduct this research, different exercises of alternating intensities would be researched and which cytokine proteins are released more with what impact it has on the immune system. There is a significant rise in inflammatory and anti-inflammatory cytokines caused by certain levels of exercise. There is already much research done in the world about different types of exercises and their effects on immunity, so the goal of this research is to find the information about different intensities of exercises, their relation to cell-mediated immunity through the release of anti-inflammatory cytokines, and conduct a comparative-meta analysis.

Ridgefield High School

Teacher: Patrick Hughes

Project # 168

Saussy, Kathleen

Macrophage Treatment for Systemic Lupus Erythematosus

Research Proposal, Health & Medical

Like most autoimmune diseases, systemic lupus erythematosus (SLE) lacks an abundance of effective treatments for patients. This proposal aims to find a new, effective treatment combatting the macrophage deficiency causing defective apoptosis in SLE patients. Human-derived monocytes can be isolated from blood and when cultured in the presence of macrophage colony-stimulating factor (M-CSF) or granulocyte-macrophage colony-stimulating factor (GM-CSF), differentiate into untreated (M0) macrophages. M-CSF causes a homeostatic rate of monocyte differentiation and macrophage proliferation, whereas GM-CSF causes uninhibited proliferation. Therefore, the patient-derived isogenic monocytes will be cultured with GM-CSF and interleukin-4 and interleukin-13 to create a serum of homogenous M2 macrophages (which have higher rates of phagocytosis and an anti-inflammatory role) to be injected back into the patient to combat the secondary necrosis occurring in tissues as a result of defective apoptosis, as more post-apoptotic cells will be effectively phagocytosed. If this treatment is successful, the M2 macrophages will be successfully proliferated in large quantities in culture, and once injected back into the patient, will reduce many of the symptoms of SLE, including fever, fatigue, joint pains, weakness, and skin rashes on the face, neck, and upper body. The narrow safety margin of this treatment implies that careful dosing will be required and extremely important upon administration. An overdose of macrophages can lead to more severe symptoms of fatigue, consistent fevers, headaches, and other lymphatic problems. However, with the guidelines of previous studies, it is possible that these implications can be avoided.

Weston High School

Teacher: Stacey Greenberg

Project # 169

Savarese, Louis

Effectiveness of Trawl Nets Fitted with Tightly Sized Rigid Grids in Reducing Large Fish Bycatch in Butterfish and Other Small Fish Markets

Research Proposal, Environmental

Bycatch Reduction Devices (BRDs) are often placed in trawls to reduce bycatch of many kinds of sea organisms. Currently there is no design specified to reduce bycatch of large fish caught from nets targeting smaller fish. The purpose of this endeavor is to create a model of a BRD that excludes larger fish from trawls while maintaining the catch of smaller fish in order to reduce the amount of endangered species that get maimed or killed. Background research will be conducted and models will be digitally created and redesigned until the design is deemed effective. Materials will be obtained and the replica net created with the necessary tools. To test the design, two replica trawl nets will be constructed, with one serving as the control group and one as the experimental group containing the new BRD design. Testing will be conducted in a local body of water. The difference between the experimental and control groups will be compared in terms of the amount of target fish caught and bycatch. If the experimental design shows significant levels of bycatch reduction, and shows no significant target fish catch reduction, then the design will be considered effective. This research could lead to a new BRD useful for all markets in which the targeted catch is of a relatively small size and will help marine life wherever it is implemented.

Amity High School

Teacher: Catherine Piscitelli

Project # 170

Seal, Abigail

Statistical Percentages and Potential Causes of Misophonia

Research Proposal, Behavioral

By understanding the potential causes of Misophonia and the approximate percentage of patients obtaining Misophonia, people will understand why this brain disorder is existent. Using fMRI scans, I would measure the brain activity of a group of patients without Misophonia and a group with Misophonia. While examining the brain activity, I would play universally pleasant sounds, universally unpleasant sounds, and trigger sounds. Additionally, I might show each group a video of universally pleasant sights, universally unpleasant sights, and visual triggers. While playing the sounds and videos, I would expect to see heightened excitement of activity in the Misophonic patients' autonomic nervous system and limbic system. I would expect to see a lesser state of excitement in the group without Misophonia. With this collected data, I will be able to understand what happens in the brain as triggers are played/viewed by misophonic patients. This will help researchers get closer to understanding the cause of Misophonia.

Ridgefield High School

Teacher: Aine Kapell

Project # 171

Shah, Layla

Comparison of Instant Yeast (Commercial Bread) and Wild Yeast (Sourdough Bread) in Terms of Glucose Content, Protein Content, and Elasticity.

Research Proposal, Physical Science

According to the Centers for Disease Control and Prevention (CDC), over 10% of the U.S. population is diagnosed with diabetes and must limit themselves to certain foods regularly. This includes certain types of bread since most commercial breads have a high glycemic index (high amount of carbohydrates), which spikes blood sugar levels. The purpose of this study is to demonstrate that sourdough bread - made with wild yeast - has higher protein and glucose contents and is more elastic than bread made with instant yeast, providing a better alternative for diabetics. To compare the different bread/yeast types (wild vs instant), the glucose and protein contents of each will be measured using glucose test strips and the Bradford Assay, respectively. By diluting small amounts of each dough and using these two tests, the contents of glucose and protein will be acquired. Additionally, the elasticity of the dough will be assessed by stretching the dough, letting gravity pull on it over time. These experiments will likely show that resulting from the longer fermentation process of sourdough, the glucose content and protein content will be higher, and there will be a greater elasticity since more lactic acid is being produced when compared to that of a commercial bread dough made with instant yeast. Collectively these results will demonstrate that bread made with wild yeast provides diabetics with an option that will prevent spikes in blood sugar levels and allow them to enjoy bread without issues.

King School

Teacher: Victoria Schulman

Project # 172

Shen, Sophie

Grape Seed Polyphenolic Extract as a Potential Therapeutic Agent in Tauopathies using *C. elegans*

Research Proposal, Health & Medical

Tauopathies are a group of neurodegenerative disorders characterized by the aggregation of abnormal intracellular tau protein in the brain. Tau aggregates in the presence of negatively charged molecules, first forming oligomers, then paired helical filaments, and ultimately neurofibrillary tangles. The accumulation of tau in the brain and destabilization of microtubules eventually leads to neuron death. *Caenorhabditis elegans* are a nematode commonly used as model organisms for tauopathies, advantageous due to their short lifespan, relative simplicity, and ability to exhibit more complex locomotive behaviors. In *C. elegans*, tau expression and aggregation impairs proprioception: perception of the body's position and movement. This proposed research aims to measure the efficacy of grape seed polyphenolic extract in reducing the neurodegenerative symptoms in mutant tau expressing *C. elegans*. Previous studies have observed that grape seed extract may inhibit tau peptide aggregations, as well as dissociate preformed tau peptide aggregates, suggesting grape seed extract as a potential novel therapeutic agent of tauopathies. In this research, the amount of tau aggregation will be measured, comparing control *C. elegans*, tau expressing *C. elegans*, and tau expressing *C. elegans* treated with grape seed extract. Proprioception will be measured via a thrashing assay, evaluating the sinusoidal wave pattern created by the bending of the *C. elegans* head and body. This proposed research will help determine the efficacy of grape seed polyphenolic extract as a potential therapeutic agent in tauopathies, possibly warranting further research beyond *C. elegans*.

Ridgefield High School

Teacher: Ryan Gleason

Project # 173

Shetty, Aashni

Prediction of Future Mutation Profiles in SARS-CoV2 Based on Sequencing Analysis of Viral RNA in Saliva Samples from Immunocompromised Covid Patients

Research Proposal, Behavioral

A major problem with mass vaccination efforts to combat the COVID-19 pandemic is the emergence of SARS-CoV-2 variants that could evade vaccine protection. Immunocompromised patients infected with COVID-19 have a longer duration of viral clearance, allowing the virus several opportunities to mutate in attempts to evade immune surveillance, such as the recently discovered Omicron variant. The prediction of mutation profiles, especially variants of concern that can evade immune surveillance, will help in the design of effective mRNA vaccines for protection against all possible variants that could spread and prolong the pandemic. A pilot experiment will be conducted with two vaccinated population sets, 50 immunocompromised and 50 normal individuals with acute COVID-19 infection. Saliva samples will be collected at early, middle and late stages of infection. Using standard molecular techniques, RNA will be extracted from saliva, RNA-libraries will be created and sent to a genomic core facility for next-generation sequencing. Using bioinformatic software analysis tools, data obtained from sequencing will be aligned to publicly available SARS-CoV-2 databases to identify genomic variants for mutations in the spike protein, in both populations. The experiment will identify mutations in the spike protein that evade both the normal immune and vaccine-derived immune response. It is also expected to see an increase in the number of common as well as novel mutations in the immunocompromised population when compared to the normal population. The same data set can provide evidence for recombination of SARS-CoV-2 with other respiratory viruses from co-infections commonly observed in immunocompromised individuals.

Newtown High School

Teacher: Timothy DeJulio

Project # 174

Smith, Kayleen

Efficacy of Schroth Treatment on Scoliosis

Research Proposal, Health & Medical

There are more than seven million people with scoliosis in the US alone, and for 20 percent of these cases, it impairs their quality of life. Scoliosis is a medical condition in which there are abnormal curvatures in the spine. The Schroth method, a type of treatment for idiopathic scoliosis, uses an exercise approach that combines stretching of muscles and the back, strengthening of bones and musculature, and specific breathing patterns to halt progression of the condition and to stabilize spinal curves. By researching this method's efficacy, further spinal damage can be reversed without spinal movement prevention, which other treatment methods focus on. This will be done by analyzing studies done on the regression of curve angles over time while treated by different methods, contrasting their effectiveness and efficiency in fixing the condition. By proving the Schroth method makes necessary progress without damaging areas of the body surrounding the spine, scoliosis can be corrected with less expense and more ease.

Ridgefield High School

Teacher: Aine Kapell

Project # 175

Stevenson, Ryan

The effect print parameters have on the strength of 3D printed sleeve bearings compared to aluminum alloys

Research Proposal, Physical Science

Current techniques for the manufacturing of metal alloy based products such as sleeve bearings are incredibly inefficient, requiring high levels of energy to achieve temperatures in excess of 1000 degrees fahrenheit. Current alternatives include 3D Fused Deposition Materials (FDM), made most commonly with plastics such as polylactic acid (PLA). To determine how FDM materials can be optimized for strength and performance compared to aluminum alloy, 3D print specifications for a PLA sleeve bearing will be varied. Three factors (layer height, infill, and print orientation) will be varied to determine the strongest FDM sleeve bearing, printed in the shortest time, with minimal cost. Strength will be measured by applying a rotational force from a steel shaft, driven by an electric motor. To simulate load on the shaft, weight will be placed on the opposite end, concurrently, a constant flow of 1 milliliter per second of lubricant will be injected into the bearing, moving through channels before falling into a lubricant reservoir. After 1 hour, strength will be measured by percent mass lost and total mass lost in grams. It is anticipated that a FDM sheath printed with 100% infill bearing using a layer height of 0.25mm, and oriented parallel to rotation, will be as strong as an aluminum alloy sheath. This anticipated outcome would serve to initiate a reduction in metal alloy usage and increase in FDM usage. The impact of this would be a reduction in energy expenditure in the industrial sectors in producing sleeve bearings.

Staples High School

Teacher: Amy Parent

Project # 176

Subramanian, Mallika

Essential oils from thyme and rosemary in combination as an antibiotic-sparing agent to treat Escherichia coli-caused urinary tract infections

Research Proposal, Health & Medical

Antimicrobial resistance (AMR) is one of the biggest healthcare emergencies today, with urinary tract infection (UTI)-causing uropathogenic *Escherichia coli* (*E. coli*) (UPEC) antibiotic resistance being one of the most urgent issues. The development of biofilms, matrices of bacterial cells, by UPEC is crucial for UPEC persistence in the urinary tract and its UTI-causing ability. Antibiotics fail to pierce the full biofilm, leading to continuous infection, ensuing more antibiotics, increasing AMR. Little has been done to find fully efficient UTI treatments by inhibiting bacterial and biofilm growth together. Previous research demonstrates that essential oils (EOs), especially *T. zygis* (thyme) and *R. officinalis* (rosemary) EOs, can combat bacterial growth with the same effectiveness as antibiotics, and efficiently inhibit biofilm growth; also demonstrated is that EOs in combination can be more effective in inhibiting bacterial and biofilm growth than when used individually, but the ratios have not been optimized. In this experiment, *T. zygis* and *R. officinalis* EOs will be tested on *E. coli* in different ratios to establish an optimal EO combination to effectively inhibit both bacterial and biofilm activity. Agar disk diffusion will be used to evaluate antibacterial activity, and a CFU/mL assay will be used to measure antibiofilm activity. It is hypothesized that the two EOs will work synergistically against UPEC. The results could indicate EO combinations to be used as part of alternative treatments via EO encapsulation to spare antibiotic use for UPEC-caused UTIs. This can lead to reducing exposure to, spread of, and resistance to antibiotics.

Staples High School

Teacher: Amy Parent

Project # 177

Taylor, Lindsay

Sustainable Satellites: Creating an Ocean-Monitoring Satellite Made Entirely Out of Recycled Materials

Research Proposal, Physical Science

For my Stem Fair project, I plan to propose a design for a satellite made entirely of trash and recycled materials. My project will present a design for an economically and environmentally efficient satellite that observes oceanic climate patterns. I will also design a radio transmitter that is necessary for the satellite to communicate with research stations to share the data. To create a radio transmitter, I plan to use recycled antennae in order to minimize the amount of energy and materials needed to transmit the frequencies. To collect information, the satellite will require a power source and a camera, which I will create using recycled technology. I will present possible hulls for the satellite that ensure the design is strong enough to withstand the climate of outer space, which will be created from an alloy of recycled metals. I plan to propose different ways to use recycled materials to create a power source and a camera that are both environmentally friendly and highly accurate. The satellite will be able to record data about the oceans and polar ice caps. I plan to craft a satellite that is both inexpensive and long lasting. It is extremely important to collect reliable data about the oceans and polar ice caps, so I will design my satellite to maximize reliability and accuracy while minimizing the cost to produce it and its environmental impact.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 178

Trudel, Evelyn

The Research of Hand and Foot Impressions on the Tibetan Plateau in Comparison with Other Prints That Have Been Lithified by Hot Springs to Determine Criteria to Prove if They are Intentional

Research Proposal, Behavioral

In Quesang, on the Tibetan Plateau, we report a sequence of foot and hand impressions placed on a section of softened travertine. The travertine was created by the water from a hot spring, which has now become inactive and caused the travertine to lithify which retained the prints. On the slab, there are four right-footed footprints and five handprints. Many similar prints have been lithified due to the inactivation of a hot spring. The objective of our study is to compare our panel with other panels that have been lithified by a hot spring and determine ways to prove if they are intentional or accidental. We will excavate samples of our prints and use uranium-series dating and kernel density estimation to measure the age of the rock. We will also create a 3D model with the help of Agisoft Metashape and OpenMVG. This will allow us to date the implantation and gain knowledge of the size and depth of the prints. We will then identify similar prints and collect data from studies on them. Afterward, we will compare their data and use this information to create criteria for what will be considered intentional. These criteria will consist of questions and thresholds that must be reached. This test will then be conducted on our prints to prove its effectiveness. This will allow us to be able to determine if future prints are intentionally placed or not.

Darien High School

Teacher: Guy Pratt

Project # 179

Tullis, Ada Rose

Membraneless CO₂ filtration in application to Micro-plastics removal from automatic washers

Research Proposal, Environmental

Microplastics are small plastic particles less than five millimeters which are hazardous to our aquatic life and humans alike. Automatic washing machines are responsible for 35% of microplastic production. Although there are already filters to remove microplastics from home washing machines, using methods like reverse osmosis filtration which is a proven method of microplastic removal and carbon fiber filters. However as of 2017 membraneless filtration using CO₂ has been proven to work by dissolution of CO₂ to create a solute that will cause diffusiophoresis. And colloidal particles such as microplastics will be able to be removed.

Ridgefield High School

Teacher: Patrick Hughes

Project # 180

Tullo, Bowen

Removing aquaculture wastewater through cultivated macroalgae for aquafeed

Research Proposal, Environmental

Eutrophication, or the overabundance of nutrients in water bodies, causes widespread habitat destruction and loss of wild biodiversity with the excessive growth of algae from waste chemicals. The aquaculture industry is a contributor to this issue, as effluent from aquacultured organisms is flushed into waterways, creating an overabundance of nutrients. Additionally, the necessity for high quality feed in aquaculture prompts aquaculture workers to harvest wild prey fish to supply poly-unsaturated fatty acids (PUFAs) to promote health; a resource that is found within algae. Macroalgae have a high PUFA content, which consumes waste products to grow. These experiments seek to find a method of lessening aquaculture's effect on eutrophication by filtering out nutrients using cultivated macroalgae that can be used to provide nutrients to organisms. Macroalgae species will be purchased or collected. Each sample will be stored in a container until the experiment is prepared. To conduct the experiment, 10 liter buckets of seawater will be used to house the macroalgae. Nitrate, phosphate and ammonia will be added to each bucket prior to experimentation. Over one week, each trial subject will be monitored on a 12h: 12h lighting cycle under T5 bulbs. Additionally, oxygen will be supplied to the tank through a hose to sustain the algae during the dark cycle. Daily recordings of dissolved nutrients in mg/L will be taken. At the end of each week, the algae will be removed and weighed to determine an estimated growth pattern.

Amity High School

Teacher: Catherine Piscitelli

Project # 181

Turner, Lindsey

Effects of increasing water temperature in the Long Island Sound on plankton diversity and abundance and bivalve growth

Research Proposal, Environmental

This study aims to determine how temperature change in the Long Island Sound affects plankton diversity and abundance, which could affect bivalve health and growth. Plankton are a vital food source for many economically and ecologically important species, including bivalves, so it is essential to determine the best conditions to grow and thrive. Previous studies in the Long Island Sound have measured increased water temperature during recent years (Mercaldo-Allen et al. 2020). This is expected to correlate with a decrease in plankton diversity and abundance and decreased bivalve growth. This study will compare zooplankton and phytoplankton diversity and abundance data collected by CT DEEP at locations across the Long Island Sound, along with water temperature data collected by Milford Laboratory. These factors will be compared to oyster and clam growth and abundance data. The results of this study will be helpful for understanding if bivalves may lack a diverse or sufficient diet to promote growth, which could be caused by a decrease in upwelling and poor nutrient cycling due to warmer surface temperatures.

Darien High School

Teacher: Guy Pratt

Project # 182

Verdejo, Samantha

The Use of Sonification for Translating Proteins to Locate Mutations in Alzheimer's Patients

Research Proposal, Health & Medical

Alzheimer's is a neurodegenerative disease that attacks the cognitive functions of many individuals globally. Alzheimer's can result in issues like memory loss and behavioral changes. Protein tangles and brain plaque are main contributors to the development of Alzheimer's and there is no cure. It is difficult to unfold the misfolded proteins in order to detect the cause of possible mutations. Observing the mutated proteins of beta-amyloid and tau tangles in individuals with Alzheimer's and others without will show the effect of Alzheimer's on those specific proteins in the brain. By using sonification aided by A.I., amino acid sequences can be translated into music. Therefore, the mutations in the proteins will be more distinct when listening to the data. Determining the areas of the mutation will assist in finding its location which will provide information on what parts of the protein are being altered. As a result, new treatment would be targeted at the specific mutations rather than having the purpose of temporarily lessening the effects of Alzheimer's. Creating new treatment, specifically to reverse the effects of misfolded beta-amyloid and tangles of tau, could lead to permanent cures for Alzheimer's disease. The research could also help to create treatment for early Alzheimer's diagnosis to prevent the illness from becoming more severe.

Ridgefield High School

Teacher: Aine Kapell

Project # 183

Voellmicke, Jacob

The Effect of Player Height on Risk Factor for Injury in Adolescent Baseball Pitchers

Research Proposal, Health & Medical

While some researchers have looked at the risk factors for injury in baseball pitchers in general, none have examined if the height of a player plays a role in risk for injury, something that this study will look at. I was recently diagnosed with an injury in my elbow, so I wanted to learn more about this and help others to avoid injury in the future. I have been communicating with the Hospital for Special Surgery on a study that they are conducting on risk factors for injury in baseball pitchers, and will be able to help collect data. This will be a survey study, in which surveys are sent out to a variety of players across the country, ages 12-21, using REDCap software. The survey will ask about pitching practices, any past injury, life outside of baseball etc. to get comprehensive data. I will then utilize this data to answer my own question as to how the data may be different or similar depending on the height of a player. I expect to find that height and risk for injury have a clear correlation, in that the greater a player's height, the more at risk they are for injury. If this proves true, it would be a big step in the right direction for injury prevention, and players would be able to take the proper measure to stay safe when throwing.

Ridgefield High School

Teacher: Ryan Gleason

Project # 184

Wadhvani, Krishin

Effect of highway geometry of trumpet type-A, trumpet type-B, and directional-Y interchanges on interchange safety

Research Proposal, Physical Science

Trumpet loop ramps have been identified to have consistently higher automobile accident rates than other ramp types. However, little research has been done since the Highway Research Bulletin Board in 1961 to address these findings and analyze alternatives, even as the Trumpet continues to dominate as the choice for the three-legged interchange. This observational study will evaluate highway geometry and accident rates on Trumpet Type-A, Trumpet Type-B, and Directional-Y interchanges in Connecticut to establish a statistical model for accident frequency. The research will utilize the Connecticut Transportation Safety Research Center databases to compare inner-turning radii, outer-turning radii, average annual daily traffic, average slope, and number of lanes to identify most-correlated factors in accident models. It is anticipated that the Directional-Y interchange will be safest due to the larger turning radii inherent in design. The importance of a larger inner-turning radii may change common practices in favor of larger, safer turns.

Staples High School

Teacher: Amy Parent

Project # 185

Wallace, Heather

An Efficient, Effective, and Engineered Process of Discovering and Classifying Micrometeorites

Research Proposal, Physical Science

Micrometeorites are minuscule geologic forms that originate from asteroids in our solar system that have reached Earth's surface after traveling through interplanetary space. 40,000 tons of material fall to Earth every year, and being some of the oldest matter in the universe, it holds the key to discovering the origins of our solar system and therefore the origins of human life. There are several established methods for classification and detection, most of which involve sorting the extraterrestrial from the terrestrial. However, there has not been a comparative study to discover which method is better able to identify the most micrometeorites most efficiently. In addition, the methods that exist are labor-intensive and inefficient, preventing professional and civilian scientists alike from examining a greater volume of dust. Using the Scientific Method and the Engineering Design Process, this research will analyze which of the pre-existing methods is the most effective and then will industrialize this process using invented machinery to make the resulting method more practical. Though microscopic observation must continue to be done by humans, technology can be applied to the preparations needed to refine a sample. The most effective method is expected to be a combined flotation-size screening method, which accounts for non-magnetic as well as magnetic particles. Proposed machinery includes an improved tool for dust sample collection and an autonomous robot to sort the particles based on size. This research will increase the range of micrometeorites discovered and contribute to what we know of asteroids and the solar system.

Ridgefield High School

Teacher: Patrick Hughes

Project # 186

Wijsekera, Adithi

Creating an Efficient and User-friendly Application for Parkinson's Patients to Track Current Symptoms and Monitor Disease Progression

Completed Project, Health & Medical

Parkinson's Disease (PD) is a chronic, degenerative disorder that affects movement. It is crucial to monitor motor and non-motor symptoms to track the worsening of the illness. Current technologies fail to efficiently record symptoms. The project's purpose is to provide a more accommodating method for Parkinson's patients to input their motor and non-motor symptoms to track disease progression. App requirements are that it is user-friendly, records motor and non-motor symptoms, and follows Parkinson's development. Utilizing MIT App Inventor to design the application, an algorithm will be coded to track motor and non-motor symptoms, and create a point system where each symptom is assigned a point value. The app will ask users if they have experienced specific motor and non-motor symptoms; users rate symptom severity on a scale of one to ten. After inputting symptoms, patients will receive a total point value, notifying them of their PD progression. Previous inputs will be saved into the algorithm so periodic comparisons can be made. The app will be tested by a Parkinson's patient group for three weeks. It will be downloaded on devices of the Parkinson's patients for them to access. After using the app, the survey will be administered and ask them to rate the app based on certain criteria. The app will be considered successful if at least 75% of participants rate it a 7/10. Through this app, PD patients reflect on the progression of their condition over time. Doctors can easily communicate with patients, making clinical visits more meaningful.

Amity High School

Teacher: Catherine Piscitelli

Project # 187

Wolters, Katherine

Sing Out Loud Therapeutic Chorus for People with Parkinson's Disease

Research Proposal, Health & Medical

Parkinson's Disease (PD) is the second most common neurodegenerative disorder, affecting one million Americans and six million people worldwide. PD manifests physically with symptoms of tremor, rigidity, and hypokinesia, and can lead to balance problems, gait disturbance, depression, dementia, and dyskinesias, among other problems. 60-90% of patients experience voice impairments due to decreased range of motion of lip and tongue muscles, reduced respiratory capacity, and reduction in size of jaw movements. These issues result in monopitch, decreased vocal intensity, and breathy vocal quality. In this study, 11 patients will participate in an 8 week long telehealth singing program consisting of one one-hour long session per week. Patients will be assessed on pitch range, maximum phonation time, vocal intensity, vowel sustanation, and quality of life, among other outcome measures at baseline, the 4 week mark, and after the conclusion of the intervention. It is expected that patients will experience improvements in all outcome measures and an increased quality of life. If successful, this approach could greatly widen the availability of treatment for patients with PD.

Darien High School

Teacher: David Lewis

Project # 188

Womer, Molly

Engineering an attachment to aid people with upper limb limitations in using a standard loop end mop

Research Proposal, Health & Medical

In the US 41,000 people live with upper limb limitations including monoplegia, or upper limb amputation and 40% of prosthesis users report that the most challenging task to perform is household chores, such as using a standard loop end mop which required two hands due to need to push and pull the mop. 3D printing is becoming increasingly popular in the medical and assistive devices world, because of its cost effectiveness and versatility. This proposal could aid people with upper limb limitations by 3D printing an attachment that fits on a loop end mop to help those affected by upper limb limitations. This design needs to be able to be put on with one hand, provide necessary stabilization for the pushing motion, be comfortable, and not add significant weight to the existing mop. It will be inspired by a forearm crutch, with a loop attaching to the bicep, and other components for support. Additionally focuses will be on the user's ability to tighten and take off the attachment with one hand. Once printed the attachment will be tested with participants on how well they can put on the attachment with one hand, use the mop effectively, and the overall comfortability. Providing assistive devices to complete household chores is a crucial step to enabling people with limb limitations to complete instrumental activities of daily living.

Amity High School

Teacher: Nicholas Shamp

Project # 189

Yee, Emily

Exploring the Effects of Psilocybin Vs. SSRIs and their Side Effects in Treating Depression

Research Proposal, Behavioral

Depression is one of the biggest mental health problems existing today. SSRIs (Selective serotonin reuptake inhibitors) have been proven to not be as beneficial as they seem, the use of psilocybin could be a solution to treat depression for those who oppose cognitive therapy. Side effects haven't been observed as deeply in both drugs which is why I am interested in exploring both positive and negative effects. After reading journal articles, I would like to take part in a study with the use of oral doses of psilocybin and the use of SSRIs on humans with depression over a long period of time and analyze and compare results. I am planning on researching the different effects of psilocybin and SSRIs in terms of side effects and possible risks of addiction. These results will provide data to see whether psilocybin or SSRIs are overall more beneficial over long periods of time. I am expecting to see beneficial effects in the behavior and mood with psilocybin, but also other possible negative effects, along with SSRIs. I believe SSRIs would be more addictive but provide more helpful effects at first glance. Psilocybin also comes with hallucinogenic effects, but provides beneficial effects over time. This research could help many humans with depression that do not want to take part in cognitive therapy. It will provide another option rather than SSRIs if needed. With this data, it will further the knowledge of the use of psilocybin and SSRIs for all.

Ridgefield High School

Teacher: Aine Kapell

Project # 190

Yu, Hannah

Exploration of Finding an Alternate Magnetic Target Guiding System to Treat Liver Cancer

Research Proposal, Health & Medical

The most common form of primary liver cancer is hepatocellular Carcinoma (HCC), which ranks sixth in cancer incidence and third in mortality. The survival rate for early-stage HCC with medical intervention is approximately 70%. The common treatment for HCC is trans arterial chemoembolization (TACE). Despite its benefits in saving patients' lives, TACE has multiple side effects such as toxicity to healthy liver cells and the risk of artery damage. To overcome these side effects, targeted treatments, especially magnetic guiding, have increased in use. Using an external magnetic field to guide the delivery of magnetic nanoparticles with medicine to the target, magnetic targeted therapies offer the advantage of high efficacy and low side effects. There are many different types of magnetic targeted treatment. For HCC, therapeutic microcarriers (TMMC) are commonly used. TMMC is based on magnetic nanoparticles that can be steered with a magnetic resonance imaging system, also known as an MRI. They are delivered from the hepatic artery to the HCC nodule to create chemoembolization confined to the specific tumor area. The antitumor drug inside the magnetic nanoparticles, accurately controlled by the MRI, goes deep in the liver tumor tissue to kill tumor cells. Since access to MRI can be limited due to high cost, especially in developing countries, this research proposal will explore an alternate magnetic target guiding system to reduce the need for an MRI system.

Ridgefield High School

Teacher: Patrick Hughes

Project # 191

Zhai, Scarlett

The Effect of Bromelain Enzymes on the Growth and Spread of Oyster Mushrooms

Research Proposal, Environmental

Fungi are groups of eukaryotic organisms like mold and yeast. Fungi cell membranes are made up of proteins and lipids. Bromelain is a digestive enzyme found in pineapples. The purpose of this experiment is to determine if the concentration of a bromelain solution affects/inhibits the growth of oyster mushrooms as a natural remedy. First, I'll grow 5 clusters of oyster mushrooms from pasteurized wheat straw and mushroom spawn. Second, I'll create the bromelain solutions by cutting the pineapple and pureeing it. The solutions will be from the same batch and have the same bromelain concentration. I'll filter chunks from the juice and separate them into spray bottles labeled with the concentration of bromelain. The first solution is 100 mL of juice, the second is 75 mL of juice & 25 mL of water, the third is 50 mL of juice & 50 mL of water, the fourth is 25 mL of juice & 75 mL of water, and the fifth will be the control using 100 mL of water. I'll spray each solution twice onto the base of the mushrooms every day for 10 days while observing and measuring the mushrooms. I'll repeat this process for every solution and analyze the results. The mushroom's length from base to cap and the thickness of its stem will be measured for the quantitative data. The color and shape of the mushroom will be observed & recorded for the qualitative data. I'll test my control and compare the data to determine if there is a difference.

Amity High School

Teacher: Catherine Piscitelli

Project # 192

Carlson, James

Machine-Learning Driven Analysis of the Effects of Early Foraging Experiences on Long-Term Foraging Ability in *Acheta domesticus*.

Research Proposal, Behavioral

Conservationists must ensure that their methods of conserving and repopulating animal species are effective. The consensus among scientists is that animal captivity hinders the development of vital behaviors such as mate finding, reproduction, and feeding (Abdullahi Ali et al., 2018). However, most studies supporting this conclusion were conducted using manual data collection methods, which rely on human observation for data collection and processing. It is essential to re-evaluate this consensus as modern, computer-based data collection methods become more mainstream, as they may extract information missed by traditional methods. This study aims to employ Computer Vision (CV) and Machine Learning (ML) techniques to record an observable relationship (or lack thereof) between nymph house crickets (*Acheta domesticus*) that are required to begin foraging from birth (control group, CG) and those that have food provided to them until adulthood (experimental group, EG). We will develop a program to continuously automatically gather quantitative data on the Mean Movement Distance (MMD) and Mean Movement Time (MMT) of the two groups. If the EG exhibits a statistically significantly smaller MMD/MMT than the CG once it is required to forage, this may suggest a decrease in foraging behavior due to a lack of experience during its development stage. If the EG exhibits a similar MMD/MMT to the CG, this may suggest that foraging behaviors are innate in house crickets and do not rely on developmental experience. This study's methodology may also demonstrate how computing techniques can enhance behavioral analysis in future research.

Weston High School

Teacher: Stacey Greenberg

Project # 193

Lauria, Gabrielle

Developing a research tool to help determine the risk of Chronic Traumatic Encephalopathy in football players.

Research Proposal, Behavioral

Chronic traumatic encephalopathy (CTE) is found in many football players after they die. Players go undiagnosed until after an autopsy is performed. This is important to study because many people know little about CTE and this can be the cause of why some players die earlier on in life. Our project seeks to develop a screening and a data collection tool for football players, so that they can determine if they are at risk of developing CTE earlier on. We plan on developing a website inspired by Hudl, a sports tracking application that analyses game data. Our application will record football game footage then analyze the hits taken in the neck or head. We want to have our website to be easily accessible for coaches and athletic trainers so they are aware of a player's numbers of hits which could assess the likelihood of a concussion. Before analysis, players fill out a questionnaire focusing on previous concussions they have had. Based on the input from the user, the app will help predict if users may be at increased risk of CTE. We will be assessing bugs and user interaction so that the app will become more user friendly to players and coaches. This study will make data available for other researchers to work with in this study due to lack of research on this topic. The implementation of this website will help improve capabilities for assessing concussions in order to prevent CTE.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 194

Pascal, Gigi

Association between Gene Variants and Aggressive Behavior in Purebred and Mixed Breed Canines.

Research Proposal, Health & Medical

In 2017, one in sixty-nine people were bitten by dogs. This sparked our exploration of the genetic roots of aggression and how it correlates to certain breeds of dogs. Previous studies have identified gene variants for dog aggression using genome wide associations. It is hypothesized that differences within DNA amongst certain breeds of dogs are associated with dog aggression. In our study we mined data from Darwin's Ark. We will develop a multiple linear regression model using R studio to see if there is a correlation between mixed vs. purebred, the presence of this chromosome, and if it is homozygous vs heterozygous or neither. The dog aggression score will be the dependent variable while chromosome 18:20272961:A:C is the independent variable. We will then calculate the coefficient of determination to see which variable explains how much the dependent variable is explained by the independent variable. This number needs to be adjusted to account for the high number of variables - this means we'll also have to calculate the "adjusted r squared" which gives a more unbiased estimate. We predict that the mixed breeds will be associated with genetic variants that correlate with aggressive behavior. This research enables us to find a possible explanation behind dog aggression by applying a scientific perspective behind a dog's reactions.

Convent of the Sacred Heart-Greenwich

Teacher: Joan Fei

Project # 195

Reynolds, Matthew

The Effect of EMS Personnel Age on Patient Care Satisfaction at Darien EMS - Post 53.

Completed Project, Teams (Completed Project)

It is rare that the lives of a town's residents are in the hands of mere teenagers. Darien Emergency Medical Services - Post 53 is a student-run and operated volunteer ambulance program that serves the town of Darien, Connecticut. The focus of this project is to determine if there is a significant difference in patient care satisfaction based solely on the age of the EMS personnel. This survey-based research project assesses patient care satisfaction, or the emotional reaction of the patients, in response to the care they received. The surveys were sent to patients that had received care from Post 53 with only student volunteers or with an adult paramedic. The process of selecting patients for this study was determined by age restrictions and emergency severity. The survey consists of ten questions with answers ranging from poor to excellent that assess how satisfied the patient was with the care they received on the ambulance. Based on the responses, statistical tests (ANOVA and t-test) were used to see if there was a significant difference in patient behavioral response between calls with an adult paramedic and calls with only youth EMTs. It was hypothesized that there will be no significant difference between the age of the EMS personnel. The data trend supports the hypothesis and the idea that high-school EMTs are able to provide an equally high level of patient satisfaction as adult EMS personnel.

Darien High School

Teacher: David Lewis